SPRINGS

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PART 2

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On the same date, they produced 0.03 liter per second which ran 300 meters before disappearing. According to Haning, these springs are much stronger and course three kilometers in winter.

Floyd Scott has found archeological sites on East Antelope Creek all the way up to Icehouse Lake, whose overflow formerly fed the creek. Trader Josiah Gregg in 1840 and surveyor A. W. Whipple in 1853 probably stopped at these springs. Later they became a stop on the Fort Smith-Santa Fe trail, and in 1877-87 were used by the Mobeetie-Tascosa stage line. East Fork Antelope Creek is one of the few streams in the county whose deep holes have not been choked with sand from man-made erosion.

West Dixon Springs (5) are four kilometers west of the 6666 ranch headquarters, on West Dixon Creek. The ranch, whose headquarters is 22 kilometers north of Panhandle, is managed by Jay Pumphreys of Fort Worth and operated by Herb Propps. Several Puebloan Indian sites existed beneath caliche rockshelters here, but the overhangs were blasted down by a previous owner. The pits of two former dugouts mark the remains of a probable stage stop on the Mobeetie-Tascosa run. In early days these springs were the main source of water for the town of Panhandle. Until the 1940s, according to Scott, there was a popular swimming hole here and the creek flowed to the Canadian River. There are still some pools of live water fed by seepage from Ogallala sand on top of Alibates dolomite at an elevation of 970 meters. As shown in the table of Selected Chemical Analyses, the water quality appears to have deteriorated slightly. Many of the cottonwoods are dying.

Six kilometers south of the 6666 ranch headquarters were **Middle Dixon Springs (3)**. At this site Floyd Scott found a probable Puebloan hunting camp, with charcoal, scrapers, and pottery. There obviously was water here at that time. Now the springs are dry, but a few cottonwoods struggle on.

On East and West Dixon Creeks eight kilometers north-northeast of the ranch headquarters some small springs (1) and (2) still trickle. The one on West Dixon Creek flows from a pipe in a cottonwood grove. In summer there are only pools of water here, but in winter these creeks are reported to run through the lower few kilometers within the county.

On East Dixon Creek three kilometers southeast of the 6666 ranch headquarters are some very small springs (4). Here there was a Puebloan Indian village. Remains of dugouts at a probable stage stand on the Mobeetie-Tascosa route may be seen. According to Scott, the creek ran to the Canadian River until the 1950s, and provided a popular swimming hole at the springs. Now there is only a chain of pools about 500 meters long in which frogs, toads, and whirligig beetles play, shaded by hackberry and chinaberry trees. Triassic sandstone cliffs tower over the springs.

Nine kilometers east-southeast of the 6666 ranch headquarters small springs (8) evidently once sparkled. Here large areas of black soils on East and West Bear Creek mark the location of former lakes which were fed by seepage from Ogallala sand. They are now quite dry.

Many small springs and seeps (9) once fed McClellan Creek in the southeast part of the county, about eight kilometers north of Groom. An Indian trail followed the creek because of the abundant water along it. In 1852 Marcy made another trip through Carson County. He described these springs in 1854 as follows:

> We made an early march this morning, passing over the high hills bordering the river, and the broad swells of prairie adjoining, for twelve miles, when we reached the valley of a very beautiful stream, twenty feet wide, and six inches deep, running rapidly over a gravelly bed, through a valley about a mile wide, of sandy soil, with large cottonwood trees along the banks. I have called this "McClellan's creek," in compliment to my friend Captain McClellan, who I believe to be the first white man that ever set eyes upon it.
>
> We were happy, on arriving here, to find the water perfectly pure and palatable; and we regard ourselves as most singularly fortunate in having favorable weather. The rains of the last two days have made the atmosphere delightfully cool, and afford us water in many places where we had no reason to expect it at this season of the year.

The springs and cottonwood trees are both gone from this part of McClellan Creek, although some still exist farther downstream.

CASS COUNTY

As history dawned on Cass County, several tribes of the Caddo confederacy were living in the area. These people were largely agricultural, with only minor dependence upon hunting. They raised corn, beans, squash, sunflower seeds, and tobacco. They lived in villages of conical thatched houses with holes in the middle of the roofs to allow smoke to escape. As they valued a constant supply of pure water, they usually lived at springs.

The early explorers, who either stole food and other supplies from the Indians or traded for them, naturally came to the same springs which were already occupied. They included Juan Sabeata of the Jumano Indian tribe near Presidio, who made annual trading trips to this area, the French Henri Joutel in 1687 and Henri de Tonti in 1690, and many later explorers. All drank from

the fine springs of the present Cass County, camped near them, and watered their livestock at them.

Nearly all of the springs in the area flow from Queen City sand. This is usually a uniformly fine-grained sand which, when saturated, can become quicksand.

Because of declining water tables, many of the springs do not flow with the vigor with which they once did. In the southeastern part of the county, Texas Water Development Board studies showed that water levels declined as much as 33 meters between 1964 and 1968 alone. Gordon (1911) described the county's "streams fed by the numerous springs found everywhere along the sides of the ridges." This can no longer be said. Most of the writer's field studies were made on January 12-17, 1976.

Some springs have been covered by surface reservoirs. For example, below Knight's Bluff in Atlanta State Park several medium-size springs formerly existed. These are now beneath Lake Texarkana and probably no longer flow.

The spring waters of the county are generally of good quality. They are usually of a sodium bicarbonate type, fresh, soft, and of neutral pH. The content of iron, silica, sulfate, and other minerals may be high. Often the waters of the more mineralized springs have been used for medicinal purposes. The analyses made in 1941 showed unusually low dissolved-solids contents. This was probably due to unusually high rainfall at the time of collection of these samples and for several months preceding.

About 2.5 kilometers west of Linden and just north of Highway 11 are **Mineral Springs (1)**. These springs were valued for their health-giving qualities by the early residents of Linden around 1850. They are now enclosed in an 0.6-meter ceramic pipe, heavily encrusted with iron-oxide precipitates. They discharged 0.31 liter per second in 1941 and 1976.

Eight kilometers west of Linden, about one-half kilometer west of the Mill Creek cemetery, are **Mill Springs (13)**. This community developed around the springs in early days. The springs are surrounded by hematite or iron ore outcrops. The spring water contributed to the downstream Fuller's water-powered gin and grist mill which served the early settlers. In 1976 the discharge was 0.71 lps.

Hughes Springs (12), in Chalybeate Spring Park at the city of Hughes Springs, are the best-known springs in the county. A large Caddo village existed at the springs in early historic times. In 1687 the French explorer Henri Joutel is believed to have stopped here. From 1813 on Trammel's Trace passed the springs. In 1847 the town of Hughes Springs was laid out here. With the start of stage-coach service about 1850 the springs, then called **Chalybeate Springs**, became a welcome stop. In 1880 a hotel was built to accommodate visitors. The waters were recommended for treatment of "malaria, typhoid fever, and general debility." Two of the three fountains in the spring gazebo still flow, but not at their former rate. They trickled 0.32 lps from both the Weches and Queen City sands in 1976. A historical marker is located here.

Holly Springs (11) are six kilometers north of the town of Hughes Springs on Highway 161. The community of Holly Springs which grew up around the springs is no more. The iron-bearing springs, whose water has an orange tint, supplied an 8-hectare lake with 0.75 lps in 1976.

White Sulphur Springs (10), the largest still flowing in the county, are 8 kilometers east-northeast of Marietta on Tommy Thompson's place on Highway 77. The community of White Sulphur Springs, which grew up around the springs, is now nearly gone. There are two main springs, one north and one south of the highway. Spaight showed them on his 1882 map, and in 1899 Confederate soldiers had a reunion here. Recharge for the springs, which emitted 3.3 lps in 1976, probably comes from high hills to the south.

Gum Springs (9) are 5 kilometers south of Douglassville, southwest of the Gum Springs church. Here a group of springs flowed 0.65 lps in 1976 into a boggy area. Many gum trees are still present. The springs were used as early as 1850 by settlers from the surrounding area. They contain a bright orange precipitate, indicating that the water contains much iron.

Seven kilometers north of Linden and just west of the old Warren Springs school are **Warren Springs (8)**. Many artifacts found here, including projectile points and mortars, attest to the use of the springs by prehistoric people. Their waters are reported to have

Pavilion exclosing Hughes Springs.

been used by many early settlers in the community. In 1976 they poured out 1.3 lps.

Fifteen kilometers north of Atlanta on Highway 2327 are **Springdale Springs (7)**, in the old community of the same name. Flowing 0.65 lps from Reklaw sand in 1976, they are reported by old residents to have flowed much more strongly in the past. Many former springs in this area have dried up.

Rock Springs (6) are on Highway 251, twelve kilometers northeast of Atlanta. A pioneer settlement formerly existed here. Now a roadside park is being developed. One spring is enclosed in an 0.75-meter ceramic pipe. Several others flow nearby. The combined flow was 0.25 lps in 1976.

Rogers Springs (5), three kilometers east-southeast of McLeod, are in a piney woods. Around 1890 they furnished a water supply for a lumber camp. They flowed 0.31 lps in 1941, but only 0.06 in 1976.

Bogue Springs (4), four kilometers southwest of McLeod, are on a fault which forms an underground dam and forces the ground water to the surface. They are located just south of the old Bogue Springs cemetery. Around 1900 people from the surrounding area camped here and drank the water, which was believed beneficial for many ailments. They discharged 0.32 lps in 1976.

McInnis Springs (3), six kilometers southwest of McLeod, were also formed by a fault in the Queen City sand which trapped the underground flow of water and forced it to the surface. This was a favorite haunt of the Caddoes long before the European settlers arrived. Early white residents came from many kilometers around to obtain water here. The springs trickled 0.77 lps in 1976.

Thrasher Springs (2) are rather hard to find. They are eight kilometers east of Linden and one southwest of the Center Hill church, in a wood on the south side of Camp Creek, close to an old abandoned road. In 1911 Gordon described them as well known mineral springs, but they are now almost unknown to the residents. They produced 0.30 lps on January 15, 1976.

Eight kilometers southeast of Linden, on Hardy Dooley's place, are **Dooley Springs (15)**. In the early 1900s a logging railroad passed here and had a camp at the springs. They now supply a small lake and several houses. They flow from the Weches sand in a deep ravine in hilly country. Their discharge was 1.3 lps in 1941 and 1976.

Caves Springs (14), are six kilometers southwest of Linden, 100 meters north of the Caves Springs cemetery. Around 1870 members of a wagon train under the direction of William Caves stopped here for the night, liked the spot, and decided to stay. Only the cemetery marks the location of the former community. The springs flow from Queen City sand on top of a sandstone ledge. Many cypress trees grow here. Their discharge was 0.84 lps in 1976.

Six kilometers southeast of Hughes Springs are **Jenkins Springs (17)**, on Vance Jenkins' farm. On December 14, 1977, several springs produced 2.1 lps of iron-bearing water from Queen City sand. The springs, some of them walled in, did not fail during the 1950s drought, according to Ralph Nicholas of Daingerfield. "Hundreds" of other small springs and seeps are reported to flow along Cowhorn Creek. The creek is also called Village Creek, probably for the Indian villages which were formerly scattered along it.

CASTRO COUNTY

Springs no longer flow in Castro County. At one time many issued from Ogallala sand, gravel, silt, and caliche, which dip gently toward the southeast. The formation, which was once largely saturated with water, varies in thickness from about 25 to 125 meters.

As long as 15,000 years ago the springs and spring-fed creeks were used as living sites by Paleo-Indians. At the dawn of historic time springs maintained a flowing stream in Running Water Draw.

Many plants depended upon the spring waters for their lives. These included cottonwood and willow trees, plum thickets, grapevines, cattails, rushes, water cress, and milfoil. Animals similarly relied upon the water. Most notable were fish, frogs, snakes, turtles, crawfish, and aquatic insects, as well as the larger animals which preyed upon them. The overflowing lakes, fed by springs and seeps, made excellent havens for ducks, geese, cranes, and other waterfowl. When the springs and lakes dried up, most of these plants and animals disappeared.

Although there were other causes of the great decline in the water table, irrigation pumping of ground water is by far the greatest factor. In 1964 irrigation wells discharged 0.78 cubic kilometer of water, roughly 15 times the annual amount of natural recharge. In 1974 the annual rate of decline of the water table was as much as 1.0 meter. This was the primary cause of the failure of the county's springs. It has also necessitated the deepening of most windmill wells.

The spring waters were of a calcium-bicarbonate type, generally fresh, very hard, and alkaline. The content of silica and fluoride was usually high. The chemical analysis shown in the table of Selected Chemical

Analyses is from water in a WPA test well 5.5 meters below the surface and seven kilometers west-northwest of Flagg Springs.

Most of the writer's field studies were made during the period September 28-October 3, 1978.

There is no record of springs running on Frio (Cold) Draw in northwestern Castro County. But springs are known to have flowed on this draw downstream in Deaf Smith County and upstream in Parmer County. It is likely that seep-fed holes of live water (1) existed here, especially on T. L. Sparkman's ranch eight kilometers east-southeast of Summerfield.

Jumbo Lake was 10 kilometers northeast of Easter and just west of the Jumbo community, on Rachel and Richard Hunter's leases. The lake was once kept full by seeps (2) from Ogallala silt and sand. This was a favorite camping place of Indians. The lake never went dry in those days, and teemed with fish, some weighing 16 kilograms (35 pounds). In 1787-88 Jose Mares likely stopped here on his trip from Santa Fe to the Taovayas villages on the Red River and San Antonio. In the 1890s a Mexican shepherd lived here. Around 1900 the lake watered great herds of cattle. Many people thought the lake to be bottomless until it went dry around 1930. Immediately after an 8-centimeter rain on September 30, 1978, it was still dry. Small gullies in the pasture probably mark the location of former seeps in the lake. Pink smartweed flowers cover the lake bed.

Middle Tule Draw northeast of Nazareth apparently never possessed any permanent springs within the county. But there were some pools of live water (3). Early in the twentieth century water could still be obtained by scraping out a shallow hole, according to Harry Kleman of Nazareth.

The North Fork of Running Water Draw similarly held some pools of live water within the county at one time. Running Water Draw proper was fed by springs (4) near Sunnyside (18 kilometers west-southwest of Hart) and ran intermittently in 1920, according to Myrtle Sheffy of Dimmitt. About the same time, according to Elmer Dixon of Dimmitt, there were pools of water along the creek and a well near Sunnyside in which the depth to water was 1.0 meter.

Flagg Springs (5) were five kilometers south of the Flagg community and 11 kilometers upstream from Sunnyside on Running Water Draw. When James and Ellen Carter settled here in 1884, springs and running water were abundant, according to Alice Anthony of Dimmitt. The Flagg ranch headquarters was later located here, according to present owner Melvin Lewis. Flint points, pottery, and metates found nearby disclose that this was a living site in prehistoric times. When Lewis came here in 1936 there were still some seeps and pools of live water along the creek. They dried up soon afterward. Much sand has now filled the channel, and many irrigation wells pump nearby.

Ahumada Seeps.

CHAMBERS COUNTY

Around Trinity Bay and the surrounding country for thousands of years the predecessors of the tall, powerful Karankawa and the shorter Atakapan Indians fished and hunted. They were experts in the taking of fish, clams, alligators, and turtles from these waters, and despised tilling the soil for crops. They anointed themselves with foul-smelling alligator grease and shark oil to repel mosquitoes and flies, which are all too numerous in this area. They traveled the bays, lakes, and rivers in rafts and dugout canoes, sometimes with sails. They were among the first humans to use the springs in Chambers County. These springs are usually not large and are more in the nature of seeps which flow from the base of sandy bluffs or barrier-island deposits.

Most of the writer's field studies were made during the period August 25-29, 1975.

In 1756 Spain established the Presidio San Augustin de Ahumada on the southeastern shore of Lake Miller, about 10 kilometers northwest of Anahuac, at latitude 29°51' and longitude 94°43'. The associated mission, El Orcoquizac, was established for the Akokisa Indians, a band of Atakapans. The name *Orcoquizac* or *Akokisa* has been spelled in about a dozen other ways, depending partly on whether the Indian name was being translated into Spanish, French, or English. The site was never popular with those required to serve there. It teemed with mosquitoes and flies and was generally unhealthy. The lake water became salty periodically. One friar complained that it was "thick and stinks."

The presidio was located on a bluff about four meters above Lake Miller, which at that time apparently

was adjacent. The shore of the lake in recent times has receded some 240 meters away from the bluff, due to sedimentation caused by the Trinity River. Several small seeps (4) are present at the base of the bluff, flowing from five sand and shell deposits in this Quaternary terrace. It seems likely that these seeps were stronger before the accretion caused by sedimentation, since they were then at a lower elevation. It is probable that the soldiers at the presidio used the water from these seeps rather than the "thick" lake water. Perhaps they deepened them to form shallow wells to increase the flow. The seeps are now submerged under about one meter of water in Wallisville Reservoir, but were not in 1975 when the writer saw them.

It is also of interest to note that near these seeps one of Lafitte's vessels was chased into Lake Miller when the lake was connected with Trinity River. The 23-meter ship, which has been located at the north end of the lake, may have been carrying treasure.

Magnolia Springs (3) were located one kilometer southwest of the intersection of Interstate 10 and Highway 61. Seeping from fine sand in the Beaumont formation, they are reported to have greatly decreased in volume in recent years, probably because of well pumping nearby. Just north is the site of an old trading post and fort on Turtle Bayou which undoubtedly made use of the springs. Here also is a historical marker commemorating the Turtle Bayou Resolutions, sometimes called the first Texas declaration of independence. About three kilometers east was the headquarters of James White's huge cattle ranch in 1819. The old ranch house may still be seen south of Interstate 10. Small springs also trickle on Spring Branch about four kilometers northeast of Magnolia Springs.

Anahuac Springs (2) were located just west of the old Fort Anahuac, about two kilometers south of Anahuac. They flowed from Beaumont sand and silt at the base of the bluff. In the early days before the Trinity River had extended its delta across Trinity Bay, the springs probably flowed much more copiously. A U. S. Coast Survey map of 1856 shows a minimum depth in the channel adjacent to Anahuac of 3.7 meters. Since then the whole area has been filled with sediment from accelerated soil erosion as the Trinity greatly enlarged its delta. There is now only a large seepage area covered with cattails and other vegetation.

Generals Charles Lallemand and Antoine Rigaud and a party of French settlers bound for what is now Liberty camped at these springs in 1818. The Mexican Fort Anahuac was established here in 1830, in an attempt to halt Anglo-American colonization of the area. The springs provided a convenient water source for the fort. Red wolves are reported still to survive in this area.

Small seeps (1) are located on the Weingarten ranch on Houston Point in southwestern Chambers County at latitude 29°40' and longitude 94°55'. They trickle from silts in the back of coastal dunes and barrier-island deposits reaching five meters above sea level. The fresh water drains into small ponds on the landward side of the barrier deposits. Four hundred meters east is the site of General Sam Houston's home, where he lived intermittently between 1840 and 1862. A historical marker is present. Houston's family may have used these seeps until a well could be drilled, as they were the closest ones to his home site.

The area is littered with large ship timbers and other debris from hurricanes. The writer found banded cottonmouths to be numerous in the vicinity. There is also an old Indian shell midden nearby. The seeps were probably frequented by the same early Americans whose remains were found just across Cedar Bayou in Harris County.

CHEROKEE COUNTY

Most of Cherokee County's springs flow from Tertiary Eocene sand, sandstone, and iron ore. These formations include the Carrizo, Reklaw, Queen City, Weches, and Sparta. They dip 4 to 20 meters per kilometer toward the East Texas embayment to the west and toward the south. Unless otherwise noted, the Weches sand is the springs aquifer. Many faults influence the location of springs. As most of these formations have a relatively low permeability, water can move only slowly through them. Some springs also issue from Quaternary river terrace sand and gravel. The combination of many sand aquifers and a hilly topography has produced an abundance of springs.

From about 800 to 1300 A. D., an agricultural, highly advanced, mound-building people lived near the springs. At the dawn of history in the area, the Caddoes were found here. They cultivated many crops, including fruit trees, grapes, and berries. They raised chickens and turkeys, and were the originators of the trotline for catching fish. Beginning around 1819, the Cherokees and other tribes which had been expelled from the Southeast shared the springs with the Caddoes. In 1839 these Indians were slaughtered by the combined Texas armies, and the survivors fled to Oklahoma.

The springs vegetation usually includes ferns, mosses, and cattails; dogwood, redbud, willow, sweetgum, maple, sycamore, birch, sumac, and ash

trees; and plum thickets. Many trees, such as maple, ash, sumac, and black gum, turn crimson in fall. In spring the blossoms of dogwood and redbud brighten the woods. Briars which have sprung up in second-growth woods are a curse of the area.

The animal life in and around the springs is not what it once was. Perhaps the torrential floods caused by man's activities wash aquatic life-forms away before they can gain a foothold. But the springs feed many artificial lakes which are well stocked with fish.

Although springs are numerous, many have been dried up by well pumping and other activities. In southeastern Cherokee County the water level in the Carrizo aquifer has been drawn down as much as 52 meters. Flowing wells have also wasted much ground water.

The spring waters are usually of a sodium bicarbonate type, fresh, soft, and acid. The fluoride content is normally low. Iron content is high or very high, and generally indicated by orange slime deposits of iron bacteria. Many mineral springs formerly flowed, but as these were by their nature very weak, most are now gone. Some contamination of spring waters has been caused by improperly or inadequately cased oil and gas wells and by disposal of oil-field brines into unlined pits.

Most of the writer's field studies were made during the period November 1-6, 1979.

Rusk Springs (2) originate along Johnson Drive in northeast Rusk. Their water passes under the "world's longest footbridge" on East Fifth Street, built in 1861 and still used. (See Plate 12, d). When Rusk was chosen as the county seat in 1846, springs were shown also in the southeast corner of the plat map, a little downstream from the footbridge in the same draw. On November 3, 1979, 5.2 liters per second flowed at the mouth of the creek, from Weches sand amid raccoon tracks. The discharge appeared to be partly waste water. Just below Dickinson Drive the creek has been used as a dump ground.

Near the intersection of Dickinson Drive and East Fifth Street are other springs (4). They were estimated by Deussen to be producing 0.63 lps in 1914. On November 3, 1979, their flow, from Weches sand, was 0.50 lps.

Spring-fed Rusk City Park lake and belvedere

Near the east end of Egbert Street in southeast Rusk are **Seven Sisters Springs (3)**, on city property. In the 1890s they were much used by residents of the nearby New Birmingham hotel. In 1913 Pearl McLeod of Rusk lived near the springs. At that time there was still a park and summerhouse here. Each of the seven springs was surrounded by a circular brick wall. Ms. McLeod remembers a strong sulfur odor from them in the evening. In 1914 Deussen described them as "sulphur springs, used locally for medicinal purposes."

On November 6, 1979, Seven Sisters Springs flowed 0.20 lps, surrounded by many ferns in a wooded area. Most of the bricks had been scattered and buried beneath sediment. Those few still in place were thickly covered with moss.

At Rusk City Park on the west side of town is an attractive spring-fed, six-hectare lake (1). On November 2, 1979, the discharge over the spillway was 3.8 lps. The water emerges from Queen City sand. In summer the spring flow is reported to be unable to keep up with evaporation, and hence must be less than about 1.3 lps. Geese land on the lake during their migrations. Just east is the depot of the Texas State Railroad. Steam locomotives pull old passenger trains between Rusk and Palestine.

Castalian Springs (5) are seven kilometers northwest of Rusk on Hugh Jones' ranch. The Cherokees had a village here and raised orchards of peaches and plums. Remnants of their advanced pottery can still be found. For many years the springs were a resort for people suffering from various diseases. An old iron-mining settlement was located here. The springs were walled up with sandstone and later with concrete.

The water of Castalian Springs contains, in addition to the constituents shown in the table of Selected Chemical Analyses, 5.5 milligrams of aluminum per liter. On July 12, 1936, the discharge was 0.32 lps. On November 4, 1979, the spring box was mostly buried under sediment and there was no flow through the pipe, but seeps of about 0.03 lps were present. Other nearby springs produced a flow in the adjacent creek on this date of 1.9 lps. Waterfalls over hard layers of sandstone plunge into pools where small fish swim. Deer and skunk tracks may be seen.

On the east side of Dialville are **Dialville Springs (14)**, on Odell Vickery's property. The once reliable flow was piped down the hill to the Dialville schools, which were located where Harold Lee now lives. On

November 4, 1979, 0.15 lps seeped from faulted Weches sand and iron ore. The springs have been disturbed and partly covered by modern sediment. According to Lee, they now dry up in summer.

One kilometer west of Dialville are **Rocky Springs (13)**, at the Rocky Springs Baptist Church. At these springs and others at the old Lindsey home to the north, settlers built cabins as early as 1845. The original Rocky Spring behind the church was enclosed in a circular brick wall one meter in diameter. It is now filled with sediment and no longer flows. The church obtained its water from it until recent years. But other springs from faulted Weches sand made up a flow of 7.5 lps in the adjacent creek on November 4, 1979. A historical marker in front of the church mentions the springs.

Cove Springs (18) are nine kilometers northwest of Jacksonville on Pat Reagan's ranch. They emerge in an unusual location, from clean Sparta sand in a gully near the top of a high hill, 250 meters southwest of the Cove Springs Baptist Church. According to neighbor Ben Terry, the springs, formerly much stronger, then flowed in a park and were called Campground Springs. Gray soils indicate that the springs once issued in a swale, which was later gullied because of clearing and plowing of the land. Grapevines and ferns surround the pools. On November 5, 1979, the flow was 1.1 lps.

Lookout Springs (19) are in a state park just east of Love's Lookout on Highway 69 seven kilometers north of Jacksonville. An Indian campsite was located here. As a result of paving and pouring concentrated water off of the cliff, severe erosion has destroyed part of the overlook, and buried the springs beneath sediment. On March 4, 1936, the discharge was 0.63 lps. On November 5, 1979, it was 0.03 lps. About 700 meters north an old spring-fed pond has been completely filled with sediment.

Knoxville Springs (20) are seven kilometers south-southeast of Troup on Pete Pavletich's ranch. Here the old town of Knoxville was settled in 1854 by Thomas Norman and others from Knoxville, Tennessee. A stagecoach inn was located near the springs. On November 5, 1979, several springs from Queen City sand produced 0.65 lps. American beauty-berry shrubs, grapevines, and arrowhead plants thrive here in a mixed hardwood and pine forest. Pine slash, briars, and honeysuckle vines make the springs difficult to reach.

Ten kilometers southeast of Troup are other springs (21) on Gene Kee's ranch. An Indian burial ground has been found near these springs, which pour from Carrizo sand. Water lilies and cattails grow in the pools.

Myrtle Springs (22) are six kilometers southeast of New Summerfield, just north of the Myrtle Springs cemetery. In 1761 the missionary Jose de Calahorra y Saenz may have stopped here to refresh himself. This vicinity was settled around 1850. According to Manda Heath of Ponta, the springs were formerly walled up and used by many area residents. On November 5, 1979, the discharge was 0.65 lps at an elevation of 160 meters. Christmas ferns and mosses cover the banks in a wooded area. The channel has been largely choked with sand from upstream erosion.

Five kilometers east-northeast of Rusk are **Chalybeate (Iron-bearing) Springs (12)**, on Morris Hassell's property. They feed Horse Creek to the northeast. In 1914 Deussen said that they were "for many years [in the 1890s] the resort of invalids afflicted with jaundice and kindred diseases." Jewel Copeland of Rusk played at the springs as a child in the early 1900s and remembers many picnics here. Three tubs, once used for bathing in the mineral water, are still at the site.

In 1914 Deussen reported a sulfur spring (15) about 16 kilometers east of Rusk. There are still springs on Sulphur Creek in this vicinity, on Jester Sessions' ranch. A Namidish village was located nearby. On November 4, 1979, 0.55 lps poured from Carrizo sand. Minnows dart among the marsh purslane.

A second group of **Myrtle Springs (16)** is 10 kilometers east-southeast of Rusk near the Myrtle Springs church. Some maps call them **Myrill Springs**. The church was once about 1.6 kilometers southwest of its present location. There are springs at both places, in the North Falcon Creek drainage area. At the road crossing the creek east of the church, the flow was 4.7 lps on November 4, 1979, from Reklaw sand. Many squirrels were busy gathering acorns here.

Sam Houston Springs (6) are nine kilometers east of Alto on the north side of Highway 21, on Granville Adams' property. Here Sam Houston used to meet with the Cherokees to discuss matters of their welfare. The springs were shown on A. A. Nelson's 1843 *Map of the Barr and Davenport Grant*. According to neighbor Doyle Brumley, they were formerly much stronger but have been partly buried.

On November 3, 1979, a flow of 0.35 lps emerged from Sam Houston Springs among large oak, pine, and sweetgum trees. Raccoon tracks could be seen. A wooden historical marker is close to the springs. About one kilometer east, residents of the 1830 town of Linwood probably made use of the similar springs there.

Bean Springs (17) are five kilometers east of Rusk on Highway 21, on Estelle Boyd's land. Here Peter Bean settled in 1837. The springs, which rise in a deep,

circular hole, flowed 0.27 lps on November 3, 1979. A wooden historical marker stands nearby, on the south side of the highway.

About 1.5 kilometers east, and 200 meters south of Old Palestine church, are more springs which must have been used by settlers here. An old road and some stone ruins are nearby. Whirligig beetles circle among the marsh purslane and ferns. Deer tracks may be seen in the mud.

Three kilometers southeast of Alto are some strong springs (7) on R. L. Cherry's ranch. A Hainai village was located here, on Larrison Creek. On November 3, 1979, the spring-fed creek discharged 45 lps, amid much marsh purslane.

Four kilometers south-southeast of Rusk was a Civil War prisoner-of-war compound which contained as many as 3,000 prisoners. West of a historical marker on Highway 251, the site is now on Norman Alexander's ranch. In earlier times an Indian campsite had been located here. A spring-fed creek (11) which runs through the old compound area was used as a water supply. On November 3, 1979, the flow from Queen City sand was 3.5 lps.

Bowles Springs (23) are five kilometers northwest of Alto on Wade and Mabel Vining's ranch. Here Cherokee Chief Bowles had a village from 1819 to 1839. At the springs the Houston-Forbes treaty was signed with Bowles. And here President Lamar's decree of banishment was delivered to the chief. The Indians chose to fight rather than give up their homeland. In one of the darkest chapters in Texas history, many of them, including Chief Bowles, were slaughtered. A granite monument marks the site of the village. Some historians claim that Bowles Springs are in Upshur County.

Bowles Springs pour from Queen City sand around Bowles village. The largest are on the east side, producing 1.3 lps on November 6, 1979. On the west, adjacent to Bowles Creek, others flowed 0.25 lps on this date. Many maple trees and grapevines surround the springs.

Lacy Springs (8) are four kilometers southwest of Alto, adjacent to a historical monument on Highway 21. Before 1835 Martin Lacy, an Indian agent for the Mexican government, built a fort and trading post here. The springs supplied water to the fort and also to the first school in the county, located nearby. Several springs flow in the vicinity. One emerges in the highway ditch in front of the monument. On November 3, 1979, it produced 0.35 lps.

Cold Springs (10) are five kilometers southwest of Alto and 300 meters east of the Cold Springs church tabernacle. Steps lead down to the springs, which flow into a wooden box from Weches limonite rock. Ferns and mosses cover the rocks. On November 3, 1979, the flow was 0.65 lps. Many area residents still fill their water jugs here.

Ten kilometers southwest of Alto on Highway 21 is the Caddoan Mounds State Historic Site. Here in prehistoric times existed a city of highly successful merchant-farmers. They built three large mounds, one of which was used for human sacrifices. The victims were buried with high honors, with copper ornaments, large knives, and intricately carved pipes.

The site lies on a broad Neches river terrace, surrounded by springs. Two of the **Mounds Springs (9)** are on the west side of the terrace, just east of Bowles Creek, about 200 and 400 meters north of the home of Bill Grammer, park manager. The northernmost spring of these two is just below a borrow pit from which soil was taken to build the mounds. On November 3, 1979, each of these springs flowed about 0.75 lps. Arrowhead plants thrive in the bogs below the springs, shaded by hickory, maple, pecan, mulberry, and walnut trees. Deer, raccoons, and nutrias frequent the site.

CHILDRESS COUNTY

The springs of Childress County have been used by men for at least 12,000 years, beginning perhaps with the people who hunted mammoths, extinct bison, and other big game. People of various other cultures later occupied the spring sites. A Pueblo-like, agricultural race diverted spring waters to irrigate corn, beans, melons, and other crops just before the dawn of history in this area. A. V. McFarland of Childress, a noted archeologist, has collected bone, stone, and pottery artifacts of various ages from springs and former springs in all parts of the county.

Long before man arrived, the springs were a favorite haunt of bison, bears, elk, antelope, mountain lions, javelinas, and other animals. Most of the creeks were spring-fed and ran the year around, teaming with fish. Great flocks of ducks and other water fowl stopped here. The smaller creeks often had no channels, only swampy swales covered with high grasses. The larger streams were fringed with cottonwoods, willows, cattails, grapevines, and wild plums.

The early settlers industriously cut the trees, leaving the streambanks unprotected. Valley trenches cut headward, producing huge gullies. The downstream channels were widened by streambank erosion and soon were filled with sand from the hills. Overgrazing, drilling of flowing wells, and pumping of ground water

lowered the water table. The majority of the animals which depended upon the springs are now gone.

Most of the springs issue from Permian sandstone and cavernous gypsum. In some cases, especially along Prairie Dog Town Fork of the Red River, the water emerges from terrace sand deposits.

The spring waters are usually of a calcium sulfate type, reflecting the prevalence of gypsum. They are normally slightly saline, alkaline, and very hard. In some cases in the northwestern part of the county, natural salt beds cause spring waters to be very saline or brine.

Let us discuss the springs in a clockwise direction around the county, starting in the northwest. Ten kilometers east-northeast of Estelline are **Jonah Springs (1)** the most saline in the county. With a total-dissolved-solids content of 75,600 milligrams per liter (see table of Selected Chemical Analyses), their water must be classed as brine. The salt originates chiefly from the Blaine formation. Because the water was contaminating downstream water supplies, the Corps of Engineers constructed several sumps. From these the water is pumped into the Ellenburger limestone 2,380 meters below the surface, according to Ed Spillers, who operates the installation. An average discharge of 27 liters per second is disposed of in this way. As the discharge of the spring is sometimes higher than this, some of the brine may still enter the Red River. Flow records in lps by water years are:

1974	31	1977	27
1975	37	1978	83
1976	44		

The whole area surrounding the springs is white with a crust of salt. Salt minnows or killifish are able to live in the water.

Seven kilometers farther northeast are **Salt Springs (2)** on Salt Creek, mostly on the Vest ranch. These springs extend up Salt Creek for about 11 kilometers. Those near the mouth are quite saline, supporting only killifish. Farther upstream are springs which are much less saline, and here many bass and perch may be found. These springs dilute the more saline water, so that at the road crossing at the Vest ranch the total-dissolved-solids content is about 20,000 milligrams per liter — still very saline but much lower than that of Jonah Springs. Discharge records, in lps by water years, are:

1974	45	1977	71
1975	49	1978	99
1976	64		

A crust of salt along the banks surrounds salt cedar and other salt-water plants. It is planned to pump the saline water to Crowell Reservoir northwest of Crowell, where it will be allowed to evaporate, trapping the salt.

Martin Springs (10), just east of Highway 83 and north of the Red River, were probably a refreshing stop for Pedro Vial and his company in 1788, en route to the Taovayas villages on the Red River. They also were much used by cattle ranchers in the late nineteenth century. They dried up at least 50 years ago, according to Donald Crook of Childress. The site is now owned by Vera Renfro.

Buck Creek, which crosses the northeast part of the county, formerly flowed the year around, according to Mc Farland. This is no longer the case. On August 24, 1977, a flow of 7.0 lps was observed at Highway 83 but the creek was dry at the Highway 62 crossing downstream. At the county road crossing eight kilometers farther downstream there was a discharge of 0.75 lps and the creek was reported to be flowing to the Red River. A field test indicated 2,400 mg/l of chloride. A long, high wooden bridge here has been abandoned and replaced by a small culvert, since the base flow of the stream is declining so rapidly. According to Crook a spring (9) formerly flowed from a deep hole about one kilometer downstream from this crossing. It has now been buried under sand.

Ten kilometers southwest of Dodson and two west of the Arlie community were **Sand Springs (5)**, the source of Sand Creek. Until about 1925 they flowed to Arlie, where Leo Wyrick caught catfish from a deep hole. The site is still marked by groves of trees on the Medford Crowder farm. Many irrigation wells pump ground water in this area.

On the G. E. Rippetoe farm on Settlers Creek, at latitude 34°38' and longitude 100°04', are **Settlers Springs (4)**. They flow about 4.5 lps from crevices in the gypsum cliffs at an elevation of 480 meters and run to Buck Creek. According to Mike Kirkland, in 1898 the

Settlers Springs.

springs flowed past his grandfather's house, three kilometers farther upstream. Dark gray soils signify that there was once a swamp here, later drained by a headward-cutting valley trench. Wildlife abounds, and many owls, hawks, vultures, ducks, and herons live among the willows, saltcedars and cattails. The water is gypseous but used by cattle. According to Rippetoe the discharge usually dries up in summer. Many irrigation wells pump nearby.

Twenty-two kilometers northeast of Childress and two northeast of the Garden Valley community were **Garden Valley Springs (7)**. Dry for many years, they once flowed on the Catherine Crain farm, operated by the Finley brothers. A. V. McFarland's excavations here unearthed projectile points up to 12,000 years old. Undoubtedly there were springs when the people who left these artifacts lived here, and probably as recently as 100 years ago. McFarland also found a Paleo-Indian site three kilometers south-southwest of this one. Here also, in the sand hills, he is sure there was once water.

White Springs (6) formerly poured from sand along White's Creek thirteen kilometers north-northeast of Childress. Two Indian campsites were located here, on the Ray Wyatt farm. The Shoe Nail ranch headquarters was in this vicinity around the turn of the century. According to Orville Weatherbee, who lives nearby, the springs ceased flowing before 1929.

Nine kilometers east-southeast of Childress was formerly located the spring-fed Horsehead Lake (19), a natural lake on North Groesbeck Creek. It has been dry for many years, but the site is still marked by groves of trees.

Centerfire Springs (18), were located on a tributary of Scatterbranch Creek 10 kilometers south of Childress. McFarland found a Paleo-Indian campsite here. He also fished in Scatterbranch Creek until 1925. At about that time the springs and the creek went dry.

Childress Springs (8), are in the City Park Lake in Childress. B. T. Williams in 1883 and other early settlers hauled water from these springs, using corn meal to settle the sediment. On August 24, 1977, overflow and seepage through the dam was yielding 1.0 lps which ran about one-half kilometer downstream. In addition about 1.6 lps was required to counter the net evaporation from the lake. (See Plate 14, b). The water, rising from Whitehorse sandstone, contains 210 mg/l of chloride. The lake and springs dried up for a time during the drought of the 1950s. They are probably artificially recharged by the percolation downward of water used on lawns and gardens in Childress.

Across Highway 83 from the hospital in Childress was a Paleo-Indian and Archaic campsite. Undoubtedly springs (20) flowed from the Whitehorse sandstone during the thousands of years that these ancient people lived here. They have been dry for many years. The site now lies in a cotton field, soon to be developed as a housing project.

Shores Creek, about 15 kilometers southwest of Childress, flowed the year around until the 1920s, according to McFarland, who fished there prior to that time. Many Indian campsites were once based at the springs (17) which fed the creek. Now the creek is drying up, with only a few seeps from gypsum and pools of standing water.

Just southeast of Tell on Devil's Creek are **Garrison Springs (16)**, on the Flonnie Neeley property. They were evidently quite strong in the past, as projectile points of various ages up to 12,000 years indicate long use of the site by early Americans. Now there are only seeps from gypsum, which accumulate to a discharge of 0.15 lps at the road crossing of Devil's Creek four kilometers south of Tell. Wildlife is abundant among the willows, cottonwoods, saltcedars, and cattails.

In 1891 W. C. Cox built a cabin seven kilometers north of Tell on spring-fed Baylor Creek (15). The creek no longer flows, but seeps supply water to some pools. Cottonwood trees are dying here.

Four kilometers farther north on Baylor Creek McFarland remembers springs (14) before they were covered by Baylor Lake in the 1920s. They probably no longer flow.

According to Henry Williams, who lives nearby, spring-fed Rustler Creek (13) flowed until the 1920s. An Indian campsite indicates that there was a reliable water supply here for thousands of years. Willows and saltcedars still characterize the creek.

Grassy Springs (12) once originated from Whitehorse sandstone along Grassy Creek on the Rocking Chair ranch, twelve kilometers northwest of Childress. McFarland has found several Indian campsites in this vicinity. He formerly hunted here, and says the springs flowed until about 1955. Many irrigation wells pump in this area.

Sixteen kilometers north of Childress, two west of Highway 83, and just south of the Red River, springs (11) once poured from the sand dunes on John Hill's ranch. Indian artifacts, some of great age, have been found nearby. The springs failed long ago.

CLAY COUNTY

Clay County's springs have been used by man for many thousands of years. A. H. Witte of Henrietta has found many Folsom projectile points, about 10,000 years old, left by these early residents. Later the Ta-

ovayas or Wichitas were found irrigating corn and tobacco crops with spring waters.

At the dawn of history in the area, enormous numbers of geese, swans, and ducks stopped at the county's watering places. Catfish 1.2 meters long were common, as were fresh-water mussels. Bullfrogs, plovers, and prairie chickens were numerous. With the disappearance of most of the springs and their surrounding habitat, most of the wildlife has vanished.

The springs issue chiefly from Permian sandstones and Quaternary sand terraces along the Red River and larger streams. Groundwater levels have declined considerably because of man's activities, and most of the springs have dried up.

The water is generally of a sodium bicarbonate type, fresh, very hard, and alkaline. Sulfate and fluoride contents may be high.

Most of the writer's field studies were made during the period October 2-7, 1977. As the weather had been very dry for several months, the spring discharges found were probably below normal for this season.

In 1874 Buckley described some "fine large springs from a whitish sandstone" at New Henrietta. The ill-fated Santa Fe expedition of 1841 probably also stopped here. **Henrietta Springs** (22), only seeps on May 4, 1979, are on Mrs. Andrew Smith's ranch. They trickle from Permian Leonardian sandstone, feeding an earth stock tank. Willow and hackberry trees and dock thrive here.

At the 77 ranch, seven kilometers east of Wichita Falls, were the **Seventy-Seven Springs** (21). In 1872 when Dan Waggoner established a ranch headquarters here, there were "fine springs of water gushing from the high cliffs bordering the Big Wichita River." The main spring, in a sandstone bluff at the southeast corner of 77 Lake, was a favorite spot for picnics. According to ranch manager Louis Hartmangruber, it ceased flowing in 1967.

Fifteen kilometers northwest of Henrietta on the R. C. Mathews farm are some springs (5) which were used by the Santa Fe expedition in 1841. In 1977 0.06 liter per second trickled from sand among tall grass and pink canelas. A shallow pump formerly discharged the water. Turkeys are returning to nearby Turkey Creek. Some herons and other waterfowl may still be seen.

Blake Springs (4) are seven kilometers west of Charlie on Vincent Blake's dairy farm. The largest in the county, they flow from terrace sand and gravel on top of a sandstone bed at an elevation of about 300 meters amid water cress in wooded draws. There are two groups, the north group yielding 0.75 lps and the south 0.70 in 1977. According to Vernon Harrison of Wichita Falls, the city hauled water from these springs in the 1920s. Other smaller springs occur along the Red River nearby. Much irrigation pumping of groundwater in the vicinity threatens the springs.

Seven kilometers northeast of Byers, while escorting Indians "out of the heathen land of Texas," Major Robert Neighbors in 1859 found "a very good spring, two miles below the mouth of the Big Wichita, on the south bank of the Red River." Now, in dogwood-flowered woods, there are only a few seeps (3).

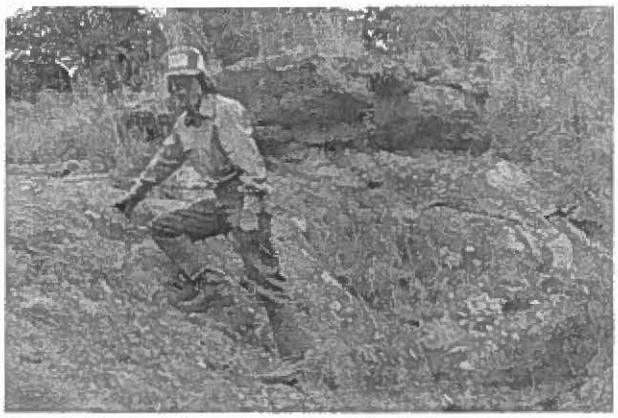
Dennison Springs (2) are 17 kilometers east of Petrolia, in Permian sandstone on a Red River bluff. An Indian village once existed on the bluff. In the 1880s James Dennison built a rock house over the springs, using them to cool dairy products. Another spring outside supplied water to stock. Some of the rock walls still stand on Frank Douthitt's property, in a wooded, briary area. The outside spring still seeps, but the one which was beneath the house is dry. A wagon road once passed the springs on the approach to the ferry below.

On a terrace on the south side of the Little Wichita River where it joins the Red River seven kilometers northwest of Ringgold were some large Taovaya or Wichita villages between 1750 and 1800, and probably long before. In 1977 springs (20) still flowed 0.50 lps among willows, grapevines, cattails, and yellow sneezeweed flowers. Located on Joe Staley's ranch, some are in Montague County.

Eight kilometers north-northeast of Henrietta were **Willow Springs (1)**. They once supplied water for Willow Springs school. The springs and the school are gone, but some willows still stand here.

Five kilometers east of Henrietta, in the old county seat of Cambridge, were **Cambridge Springs (19)**. On Frank Johnson's property, they are now only seeps from Permian sandstone in a pond among willows and cattails. They were undoubtedly important to the early settlers here in the 1860s.

Yarbrough Springs (18) are 11 kilometers northwest of Bellevue on Randy Hapgood's ranch. This was once a favorite haunt of Indians, who carved steps in the rock bluff. They are also said to have deepened the springs. Bedrock mortars used by an ancient people have been found five kilometers north. Many initials and dates cover the sandstone bluff at the springs, which were formerly in a Boy Scout camp. In 1941 they were described as "inviting springs of fresh water." Now there is only a pool of seep water shaded by



Randy Hapgood on steps carved by Indians in the rock above Yarbrough Springs.

willows.

Secret Springs (15) are 15 kilometers south of Henrietta on Carl Sanzenbacher's ranch. Settled by the Sanzenbachers in 1873, they were depicted on A. W. Spaight's 1882 *Official map of the state of Texas*. A cotton gin once used the water. In 1977 0.10 lps trickled from a hidden cove of sandstone in a small grove of trees amid cattails, purple asters, and marsh purslane. Near the old Secret Springs school about one kilometer southeast are some seeps which probably provided spring water to the school.

Two kilometers southeast of Vashti, on Dean Sanders' ranch, are **Grass Springs (17)**. They were a watering place on the 1849 California Trail. The springs were portrayed on H. O. Hedgcoxe's 1854 *Map of the Peters colony, Texas*, A. J. Johnson's 1866 *Map of Texas*, and E. H. Ruffner's 1875 *Military map of the Indian territory*. The Indians who once lived here buried a 19-liter cache of projectile points, found recently. In 1977 the springs produced 0.65 lps from sandstone bluffs in a post and blackjack oak wood. Beds of lush grass fringe the creek branches below the springs, amid pink canelas and flatsedge.

Buffalo Springs (13) are one kilometer northeast of the community of that name, on Bud Fuller's property. They were a landmark to explorers as early as 1849 and were shown on H. O. Hedgcoxe's 1852 *Map of the surveyed part of the Peters colony*. In 1857 the U. S. Cavalry camped here, finding "plenty of water in holes and fine grazing." At that time the surrounding area teamed with buffalo, deer, antelope, turkeys, prairie chickens, and quail. Fish, plums, and wild honey could be had at any time.

An Army post of sorts was located here from 1864 to 1868. In the fall of 1867 the springs flowed more than 6.3 liters per second, but usually in October there was not sufficient water. Although a well was dug at the springs, lack of sufficient water forced abandonment of the post. In 1874 Indians, reluctant to give up the springs, fought a battle for them. In the 1920s J. W. Hilburn of Shannon operated a gin here. In the 1930s Durward Morgan of Henrietta swam in the springs, and reports that a good flow existed then. Now there are only pools of live water below the massive sandstone outcrops, with purple asters shaded by trees.

Five kilometers south-southeast of Buffalo Springs are **Boggs** or **Boggy Springs (14)**, on T. A. Fuller's farm. They also were important to early settlers, and were shown on Hedgcoxe's 1854 map. In 1977 0.05 lps seeped from sandstone into cattail-fringed pools shaded by willows.

Prairie Springs (16) apparently were three kilometers south of Joy, on Luther Deweber's property. They were portrayed on Hedgcoxe's 1854 map. Now there are only seeps from sandstone along a willow-fringed creek.

Stampede Springs (12) were located one kilometer east of Shannon, near the cemetery, on the Hoff farm. In 1878 the Shannon community was known as Stampede Springs. Black soils indicate that swamps once existed here. Now the massive sandstone bluff from which the springs flowed is dry.

Myrtle Springs (11), five kilometers northwest of Shannon, were popular in former times, and were depicted on Ruffner's 1875 map. Now the sandstone outcrop and boulders are dry, but purple gayfeathers still bloom here.

Backbone Springs (9) are eight kilometers west-northwest of Shannon on the Burns estate. Hedgcoxe showed them on his 1854 map. Probably named for the ridge of Permian sandstone from which they flowed, they are now only seeps.

Ten kilometers west of Shannon were **Hackberry Springs (8)**. Dry now, they were surrounded by post oak and sawleaf daisies. An old windmill nearby probably hastened the springs' demise.

Van Dorn Springs were 17 kilometers west-southwest of Henrietta on the Little Wichita River. An abandoned Indian village was found here in the early nineteenth century. In 1941 the springs were reported still to be trickling. Now they are beneath Lake Arrowhead. A very small spring (7) still flows above lake level at Andy McCasland's place on the east shore of the lake. It is reported to be declining and no longer adequate for household use.

Ten kilometers west-northwest of Henrietta were **Rock Springs (6)**, on the J. D. Avis farm. Alice Brown, who lives nearby, taught at the Rock Springs school southwest of the springs in 1932 and 1933. They were

running at that time and used by the school. Now the massive sandstone and boulders are dry.

COCHRAN COUNTY

Hardly any springs still flow in Cochran County, but in former years when the water table was at or near the surface they were abundant, issuing from Ogallala and more recent sand and caliche. They were especially numerous along the major draws and around Silver Lake, where there was sufficient topographic relief to cause them to flow.

They were used for many thousands of years as campsites by early Americans. Fifteen thousand or more years ago the Llano Paleo-Indians killed animals that came to drink at the springs, including now extinct forms of mammoth, bison, camel, horse, and antelope. These people left Clovis spear points and other evidence of their stay in the area. More recently the Comanches used a trail along Sulphur Draw through the county, because of the plentiful springs and running fresh water. When the Spaniards arrived, they established a trail from San Antonio to Santa Fe which passed the same springs.

Before "civilization" severely damaged the land, it swarmed with bison, pronghorn antelope, deer, and prairie chickens. Water tables have fallen as much as 15 meters, primarily because of irrigation pumping of ground water, but also because of overgrazing in early settlement days. This has caused nearly all of the springs to dry up. With the destruction of the springs and their natural habitat, most of the large animals have disappeared. Waterfowl such as geese, ducks, and sandhill cranes like to winter at lakes such as Silver Lake. But the lakes are drying up and turning into dust bowls. Fish and other aquatic life cannot survive in such intermittent lakes. Where will the birds winter? The farmers of the county have been more progressive than most in the High Plains in planting trees for windbreaks, to slow wind erosion. But abandoned windmills and dying trees which can no longer reach the water table are frequently seen.

The spring waters were largely of a sodium bicarbonate type, fresh or slightly saline, very hard, and alkaline. The content of fluoride or silica was often high. In many cases the ground water has been contaminated by oil-field brines. The writer's field studies were conducted chiefly during the period April 13-18, 1977.

Just south of the Bailey County line and seven kilometers east of the state line is a former lake in a draw. Very probably small springs and seeps (4) flowed from Ogallala sand and caliche in the slopes around this lake. No one now living in the area remembers them.

Silver Lake with springs in the foreground.

In 1899 when Edgar Mills camped at Morton he found the grass to be waist high, and the draw to the west flowing water. **Morton Springs (8)** flowed from sand on the slopes of the draw five kilometers west of Morton. In 1907 they dried up, and have not flowed since. Seven kilometers south of Morton, in the shallow draw just west of the old Legon settlement, seeps or very shallow water probably existed also.

At Silver Lake or *Laguna Quemada* (Burned Lake), several old maps including those of A. W. Spaight, 1882, and W. F. Cummins, 1891, showed springs (5). Most of them still flow from sand on top of Tahoka clay.

On the southeast side of Silver Lake, in Hockley County, is a large bed of bison bones. This is probably the bed described by Pedro de Castaneda, one of Coronado's officers, in 1541. Folsom projectile points, burned rock, and broken bison bones indicate that an ancient people lived here about 10,000 years ago. Perhaps they drove the bison into the lake, where they bogged down and could easily be slaughtered.

In 1832 Albert Pike and his party were treated to an excellent meal of buffalo meat at a Comanche village by the springs.

Silver Springs in Cochran County emerge on the Jack McCutchin ranch at an elevation of 1,115 meters. The largest produced 0.63 liter per second on April 13, 1977, on the northwest side of the lake, covering about one-fourth of the lake's surface with water. On October 21, 1978, these springs flowed 0.05 lps, and the lake was dry. The slightly saline water is caught in an earth tank from which cattle drink. Other springs on the north side yielded 0.35 lps on April 13, 1977. Still others are in Hockley County. The springs' discharge is greatly affected by irrigation pumping. Salt cedars, cattails, and rushes surround them. No fish or brine shrimp were observed, and very few birds could be seen.

Ten kilometers south-southeast of Lehman, at

latitude 33°32' and longitude 102°46', the Slaughter ranch headquarters was temporarily located in 1898. Here also, with Indian artifacts found nearby, springs or seeps (6) probably flowed in former times from sand on top of a clay bed. Two abandoned windmills still stand in a grove of cottonwoods. An electric pump now pulls water from a well to fill three stock tanks.

In the southeast corner of the county, one kilometer north of the Yoakum County line and 14 west of the Hockley County line, there were formerly springs (1) which kept this draw running the year around. On a ridge to the south, one-half kilometer southeast of the Randall Beasley ranch house, many Indian projectile points, metates, and manos have been found, indicating long occupation of the site. The springs, which flowed from sand, have been dry at least since 1917, according to D. J. Peel, superintendent of the Phillips Slaughter Pipeline Co.

Along Sulphur Draw many Indian artifacts have been found, usually a sign of running water. Where the draw and Highway 125 cross the state line southwest of Bledsoe, Fred Crow of Morton states that seeps (7) were still present around 1927. The site is surrounded by sand dunes which must have furnished recharge water to the springs.

COLLIN COUNTY

Collin County's springs are nearly all located in the western half, where the Austin chalk crops out. A few existed elsewhere, especially in river terrace sands.

The springs were valued as campsites by prehistoric people. In the excavation for Lavon dam, an ancient village of fish- and clam-eating people was unearthed. Around 1700 the semi-agricultural Wichitas began to live at springs in the area, growing peach, plum, and fig trees as well as other crops. Finally eastern tribes such as the Cherokees and Delawares lived here briefly before being evicted from this area also.

Most streams were originally spring-fed and flowed constantly. The upper East Fork of the Trinity was formerly called Spring Creek. The early settlers naturally built their cabins near the best springs. Some, such as Lanson Clark on White Rock Creek a few kilometers north of the Dallas County line, used the abundant water to run mills. Natural lakes swarming with fish were numerous. Fruits and nuts such as haws, grapes, sassafras, pecans, walnuts, persimmons, plums, and honey were bountiful.

This has changed now. Ditches have drained all the lakes and sediment from plowed land has filled them. Flowing and pumping wells have lowered the water table so that many springs have dried up. And the wildlife which depended upon them has largely disappeared.

The water is generally of a calcium bicarbonate type, fresh, moderately hard, and alkaline. Most of the writer's field studies were made during the period October 26-31, 1977, a very dry period. Consequently the observed discharges are probably lower than normal for this season.

Seven kilometers northwest of McKinney are **Buckner Springs (6)**. Two kilometers downstream on Franklin Branch was the 1843 Buckner Fort and store, which made good use of the water. On October 27, 1977, about 1.9 liters per second issued from Austin chalk at an elevation of 185 meters. An additional amount is lost to evaporation in a floodwater retarding reservoir.

On Wilson Creek, six kilometers east of Prosper, are **Walnut Springs (7)**. Seepage produced 0.06 lps in 1977 near Walnut Grove church. Herons, hawks, and other wildlife frequent the springs, shaded by walnut, chinquapin oak, and other trees. A Spotted Tail Indian camp was located five kilometers southwest.

Hart Springs (8) are seven kilometers north-northwest of McKinney on the H. G. Campbell farm. These well-known early springs yielded only 0.03 lps in 1977 from Quaternary sand on top of sandstone. A chain of pools extends 100 meters downstream amid willow and pecan trees.

Liberty Springs (10) are 10 kilometers northwest of McKinney, just west of Roland. On Z. W. Gidney's dairy farm, they produced 0.50 lps in 1977 in a grove of bois d' arc and other trees. According to Gidney, about four liters of projectile points, all pointing toward the center, were found beneath a large flat rock. The springs were much stronger 35 years ago. At one time wagons lined up for 0.8 kilometer to obtain water. A post office and school were located here, and an old road passed the site.

In 1854 Alexander Robertson and family settled at **Robertson Springs (9)** on the north side of Haw Branch, six kilometers east of Celina. In 1977 the springs were only seeps of about 0.05 lps on the Fred Goldstein ranch and upstream. Minnows and small toads play in pools in the Austin chalk. Another Spotted Tail camp was located three kilometers south.

In 1841 an Indian village was located three kilometers north of McKinney near some springs (15). They are dry now. A Delaware village was located east of here.

Two kilometers south of Melissa were **Warden Springs (14)**, on Glenn Miller's property. Here William Warden and his family camped for six weeks.

Indians, reluctant to give up their springs, forced the Wardens to return to Bonham. There was an Indian village two kilometers east and a Cherokee village three kilometers southeast around 1840. The springs were much used by early settlers, and later by the Southern Pacific railroad. Now they are only seeps into standing pools of water.

In 1842 Dr. William Throckmorton settled at the "huge" **Throckmorton Springs (11)**, 13 kilometers north of McKinney, according to R. F. Hall of McKinney. No longer flowing, they are now on Leland Dysart's ranch. These may be the springs which were designated **Ojo de Agua del Venado (Deer Spring)** on a 1789 *Map of the territory between the province of New Mexico and the fort of Nachitoches in Texas.* Settlers came from as far as 80 kilometers away to obtain the water. A large depression in the hillside, surrounded by trees, marks the former location of the springs. A shallow well has been dug at the lower end of this depression, from which water is pumped for domestic and stock use. A swimming pool now occupies the original site of the springs.

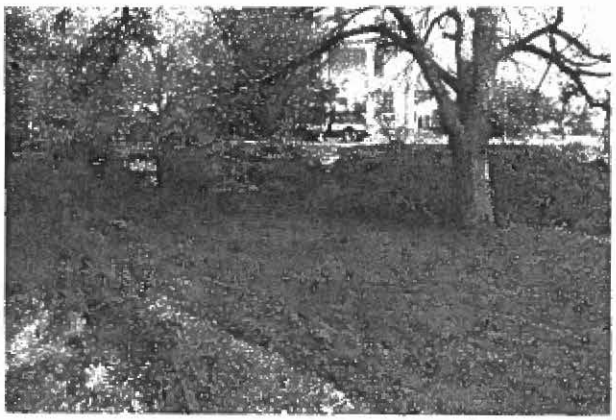
Four kilometers northeast of Anna, on Chrit Brown's land, is **Soldier Spring (12)**. Much used by soldiers during the Civil War, it is now only a seep. Four kilometers southeast of the spring an Indian campground and burial was found.

Stony Point Springs (13) are eight kilometers east of Melissa on W. F. Moore's farm. Early Stony Point settlers used these springs, and others came great distances for the water during drought periods. They were on the old Cedar Springs-to-Bonham road and are still used by travelers on Highway 545. In 1977 they poured 0.25 lps from a pipe in a springhouse in a grove of trees. Several other springs are near.

The **Spring Hill** community is six kilometers west-southwest of Farmersville. The springs (18) which gave the community its name flowed from Wolfe City sand at several locations around the bluff. According to several old residents, they have been dry for at least 50 years.

Eight kilometers south-southeast of McKinney, on Fred Willis' farm on the south side of Wilson Creek, are **Willow Springs (16)**. In 1841 the Delawares had a village here. Later the Willow Springs school was nearby. In 1977 the springs produced 0.11 lps for house and stock use in a grove of willows, cottonwoods, and pecans. A smaller spring is just to the west, where Fitzhugh Mills once stood.

Lick Springs (17) are seven kilometers south of McKinney on Marshall Watkins' farm. They are the source of Sloan Creek just west of Highway 1378. In 1977, 0.55 lps issued from joints in Austin chalk. From



Site of former Throckmorton Springs.

1871 on, the Lick Springs school to the north used the water. Settlers came long distances to the springs, which did not fail during the drought of the 1950s. They were frequented by deer and other animals as a salt "lick" in former times. Now the pools are filled with minnows.

Pegues Springs (1) were four kilometers east of Plano on Rowlett Creek. In 1873 camp meetings were held in a brush arbor here. Now they are only seeps on the Los Rios golf course.

Muncey Springs (1) are five kilometers north of Plano on the south bank of Rowlett Creek east of Highway 5. Located on the old Hagy place, they are near a pool called the Old Indian Hole. The Indians resisted being forced out of their old haunts, and killed several people here in 1844. The springs flowed 0.07 lps in 1977 for about 50 meters before sinking into the sand. Water cress is abundant, and pecan and other trees shade the scene. Dallas bedroom communities will soon overrun this area.

Five kilometers northwest of Plano on Spring Creek are **Brown Springs (3)**, west of Highway 2478. Located on the old John Harrington place, they seeped 0.06 lps in 1977. In 1850 Robert Brown and his family settled here. Housing developments are engulfing the vicinity.

Seven kilometers south of Frisco were **Clark Springs (4)**, now on Clayton Clark's property. Moscoso's party may have stopped here in 1542 to refresh themselves and their animals. Here R. C. Clark settled at "springs that rarely ran dry." They were an important stop on the Preston road. A blacksmith shop was located nearby. The springs are now dry, and a windmill pumps water for livestock. Other springs were located on Indian Creek, four kilometers south-southwest. In 1884 the headwaters of White Rock Creek, four kilometers east, contained "an abundance

of water the year around."

Mays Springs (5) are five kilometers east of Frisco on the C. H. Wallace farm. The source of West Rowlett Creek, they produced 1.7 lps in a wooded area on October 28, 1977. Four kilometers east-northeast is another group of springs, on Rowlett Creek. According to Ray Bewley of McKinney, residents came here for water from great distances 60 and more years ago, especially during droughts.

COLLINGSWORTH COUNTY

The springs of Collingsworth County have been used by man for many thousands of years, beginning perhaps with the Clovis big-game hunters. In late prehistoric time an agricultural people lived along the rivers, diverting spring waters to irrigate crops. At the dawn of history in the county the Kiowas and Kiowa Apaches occupied the area.

Long before man appeared, the springs were a favorite haunt of bison, elk, antelope, mountain lions, javelinas, and many other animals. Most of the creeks were spring-fed and ran the year around, teeming with fish.

The smaller creeks often had no channels, only grassy subirrigated swales. The larger streams were lined with willows, cottonwoods, cattails, grapevines, and wild plums.

The early settlers relentlessly cut the trees, leaving the streambanks unprotected. Valley trenches cut headward, producing huge gullies. The downstream channels were widened by bank erosion and soon were filled with sand from gullies in the hills. Overgrazing, drilling of flowing wells, and pumping of ground water lowered the water table, and the springs began to weaken or disappear. Many trees have now returned to the streambanks, but too late to prevent tremendous damage to the land. Most of the animals which depended upon the springs are now gone.

The county's springs emerge mostly from Quaternary sands, especially where they rest upon impervious Permian shales. To a lesser extent they flow from Permian sandstones and cavernous gypsum.

The water from the sands is generally of a calcium bicarbonate type, fresh, alkaline, and very hard. That from gypsum contains chiefly calcium sulfate, and is slightly saline, alkaline, and very hard.

Most of the writer's field studies were made during the period August 18-23, 1977. The preceding three months had had above-normal rainfall.

Let us discuss the springs in a clockwise direction around the county, starting at the northwest. **Wills Springs (2)**, the source of Wills Creek, are just east of the Donley county line at latitude 35°09'. They appear in a swampy area near an oak motte on Jess Coleman's ranch. In 1967 they discharged 11 liters per second. On August 18, 1977, the flow was 0.15 lps. Usually the springs dry up in summer because of irrigation pumping nearby. Artifacts such as metates and projectile points found here point to long use of the springs by prehistoric people.

Gyp Springs (11), the source of Gyp Creek, are seven kilometers southwest of Dozier, just west of Highway 1547, on Doug Coleman's ranch. The discharge was 11 lps in 1967, and also in 1977 after much rain. Much saltcedar is present. An Indian campsite was located three kilometers west.

One kilometer east of Gyp Springs are the similar **Big Sandy Springs (12)**. They flow into Big Sandy Creek amid gypsum hills almost bare of vegetation. They produced 8.1 lps in 1967 and 3.1 in 1977.

Across the Salt Fork of the Red River and nine kilometers south-southwest of Dozier were the **T Cross Springs (10)**, once used by the T Cross ranch. According to Rufus Jones of Quail, many early settlers came here for water around 1900. An Indian campsite was once located here. The springs have long been dry, the channel is buried under sand, and several windmill wells are drawing down the water table.

Coleman Springs (13) are on Dozier Creek, five kilometers south of Dozier, on Dudley Coleman's ranch. Mr. Coleman has found many metates, manos, and flint points here. Discharge records, in lps by water years, follow:

1951	28	1956	0.71
1953	6.5	1957	0.71
1954	5.2	1967	6.6
1955	3.4	1977	6.0

The figures illustrate the effect of the drought of the 1950s on the flow. It runs among willows and salt cedars to the Salt Fork.

Baxter Springs (1) give rise to Elm Creek 11 kilometers south-southwest of Shamrock, on Bob Baxter's ranch. Many springs flow from Permian gypsum and sandstone at an elevation of 675 meters amid much travertine. Elm Creek normally flows into Oklahoma. A large Indian campground existed here. Mr. Baxter has found a Sandia point (possibly 12,000 years old), celts, pipes, metates, manos, drills, and other stone artifacts at the site. In 1888 the Rocking Chair ranch moved its headquarters to these springs. There are many wildlife tracks amid the water cress. U. S. Geological Survey discharge records, in lps by water

years, follow:

1947	65	1963	88
1948	65	1964	65
1949	79	1965	59
1950	68	1966	59
1951	76	1967	59
1952	54	1968	62
1953	45	1969	51
1954	40	1970	62
1955	48	1971	26
1956	34	1972	62
1957	45	1973	40
1958	40	1974	34
1959	40	1975	54
1960	54	1976	40
1961	76	1977	51
1962	88	1978	48

The highest recorded discharge was 102 lps on May 24, 1951. The lowest, 1.6 lps, occurred on July 29, 1971.

Corral Springs (15) are the source of Corral Creek eight kilometers north-northeast of Lutie, on Edgar Wischkaemper's ranch. An Indian campsite was located three kilometers north. In 1967, 24 lps gushed from the cavernous Blaine gypsum. In 1977 the flow was 14 lps, running to Elm Creek among yellow saw-leaf daisies.

Wolf Springs (7) are on the North Fork of Wolf Creek eight kilometers east-northeast of Lutie, on Bill Janes' ranch. Once used for irrigation, they produce a clear, fast running stream that flows to Elm Creek amid much water cress. Discharge records in lps follow:

Sep. 9, 1938	28	Jun. 24, 1971	71
May 1, 1967	48	Aug. 22, 1977	36

The South Fork of Wolf Creek, although having a larger drainage area than the North Fork, has a much smaller base flow. On August 22, 1977, 4.5 lps were passing Highway 2467, through plum thickets and over beaver dams.

Eight kilometers east of Lutie and just north of Highway 1439 are **Hale Springs (16)**. On the E. S. Hale ranch, they produced 10 lps from cavernous gypsum in 1967. In 1977 the discharge was 1.9 lps, flowing sluggishly to Wolf Creek through a marsh of cattails.

Indian Spring (14) formerly produced Indian Creek 13 kilometers north of Wellington on Jim Henard's ranch. A Toweash (Taovayas) village was once located here. According to Claude Savage of Wellington, this spring was much used by early settlers. In 1967 it still trickled 1.3 lps from terrace sands, but it is now dry.

Sand Springs (6) pour into Sand Creek twelve kilometers east of Wellington. The discharge was 40 lps in 1967, 2.3 in 1971, and 8.1 in 1977 after heavy rains. They issue from sand amid willows, saltcedar, and yellow saw-leaf daisies.

Seven kilometers north of Dodson are **Cottonwood** or **Hay Camp Springs (20)**, on Ron Trafton's ranch, looked after by Ray Usselton. A Mill Iron ranch headquarters was once here. More recently the place was the site of a country club for a short time. Many seeps and small springs issue from Red River terrace sand and gravel. On July 17, 1979, the discharge was 8.5 lps. Much water cress grows in the flowing water, and large cottonwoods, willows, and plum bushes shade the site. The springs feed several small lakes containing large fish. The unused swimming pool is covered with tiny green duckweed plants.

Savage Springs (8) were eight kilometers south-southwest of Wellington on Buck Creek. Formerly issuing on Claude Savage's farm, they are now dry and buried under enormous sand deposits. Buck Creek in past years flowed throughout its length the year around, being fed by these and numerous other springs. Many irrigation wells in the vicinity have taken their toll of the ground water.

The main **Buck Springs (5)** are on Mrs. Roscoe Land's farm 13 kilometers west of Wellington. Flowing from terrace sand, they produced 48 lps in 1968, 2.8 in 1971, and 1.6 in 1977. The discharge still causes Buck Creek to flow for one kilometer downstream. Flowing wells and pumping irrigation wells are numerous nearby.

Two kilometers west is a bluff of Whitehorse sandstone called Red Bluff. There was formerly a spring (18) and an Indian camp at the base of this bluff, on E. T. Clement's property. Many stone artifacts have been found here. The spring has been dry for many years.

Four kilometers south-southeast of Quail are **O'Hair Springs (4)**, on Pat O'Hair's ranch. Numerous seeps from sand come together here in water cress- and duckweed-covered ponds above beaver dams. They are shaded by willows and bordered with snow-on-the-mountain flowers. (See Plate 9, b). The discharge was 37 lps in 1967, 3.4 in 1971, and 6.0 on August 20, 1977, running one kilometer before sinking into the sand. In winter the flow is stronger and runs to Buck Creek.

Four kilometers east-southeast of Quail are **Baggett Springs (9)**, on Aubrey Baggett's ranch. They are quite similar to O'Hair Springs, but smaller. Burned rock middens and stone artifacts have been found here. The flow was 7.4 lps in 1967 and 2.8 on August 20, 1977, running about one-half kilometer before disappearing. The discharge is stronger in winter, running to Buck Creek.

Wischkaemper Springs.

Cottonwood Springs (17) pour from sand on top of Permian shale nine kilometers north-northwest of Wellington, forming Cottonwood Creek. Rising on the Clyde Emmert and W. L. Needham ranches, they are shaded by cottonwood, willow, and bois d' arc trees. The discharge was 25 lps in 1967 and 14 in 1977. Irrigation wells and a Wellington city well are taking a toll of ground water in this area.

Wischkaemper Springs (3) are nine kilometers north-northeast of Quail, on Carl Wischkaemper's land. They issue from sand into a marshy stream supporting duckweed and cane, and fringed by willows, cottonwoods, and saltcedars. The discharge was 48 lps in 1967, 7.1 in 1971, and 39 in 1977, after much rain. The flow ordinarily courses to the Salt Fork of the Red River.

COLORADO COUNTY

The springs of Colorado County issue chiefly from Tertiary Miocene (Fleming) sand and sandstone and Quaternary (Willis, Lissie, and Beaumont) gravel and sand. These formations dip to the southeast at around two meters per kilometer, with steeper dips in the northwest portion. Some springs also are found in Quaternary terrace sand and gravel along the major rivers. Most emerge in the hillier northwest portion of the county.

Early Americans used the county's springs for many thousands of years. Archeological studies in the basin of the proposed Columbus Bend reservoir have revealed lithic artifacts associated with mussel shells and burned stone, some of which date from the Paleo-Indian period (over 7,000 years ago). In 1718 the Spanish explorer Martin de Alarcon found the Anames (Aranamas) living near springs.

Modern man's activities have caused much damage to the ground-water reservoir. Wastage of water from flowing wells in the early nineteenth century caused water tables to fall. Pumping of water for rice irrigation has done the greatest harm. As a result many springs have weakened or failed.

Erosion of formerly plowed slopes has left the scars of partially healed gullies in pastures and woods. Sediment from this erosion choked many stream channels and buried some springs. The ground water has also been contaminated by oil-field operations.

The spring waters are generally of a sodium bicarbonate type, fresh, soft, and acid. The content of silica or iron may be high. Most of the writer's field studies were made during the period April 18-23, 1978. As the preceding several months had been dry, the observed spring discharges are probably lower than normal for this season.

In 1823 Stephen F. Austin wrote of the present site of Columbus

> I am now endeavoring to find a place suitable for the Capital of the Colony and believe I shall fix it below Cummings on the River at a place now owned by Mr. Bright — the place I have in view is well watered with springs.

In 1837 a traveler wrote

> Large numbers of springs issue from the banks of the river.

Before Austin arrived there was a large Indian village at Columbus called Montezuma. In 1821 Benjamin Beason established a ferry at **Beason Springs (1)** near the foot of present Spring Street in Columbus. He also built a grist mill, saw mill, and inn at the site. In 1826 a barbecue was held at the springs to celebrate the 50th anniversary of the U. S. Declaration of Independence. Settlers came from 90 kilometers around for the event. Passengers disembarking from paddle-wheel steamers quenched their thirst at these springs. The springs are now only seeps just above the river surface east of the water works. A large municipal well pumps 100 meters west-southwest. A flowing well was drilled here early in the nineteenth century, and flowed until the 1950s according to Homer Koliba, who has a nearby museum.

About ¾ kilometer south are **Johnson Springs (7)**. They still flow well, perhaps because there are no large wells pumping nearby. The numerous springs extend from the W. R. Jones residence on Harbert Street for about a block northward at the foot of the bluffs along the Colorado River. They issue from river terrace sand at an elevation of around 46 meters. Fringed with water pennywort, part of the flow of 1.5 liters per second on April 20, 1978, disappeared beneath deep accumulations of leaves. The bluffs are

jungle of poison ivy, grape vines, and brush, making most of the springs difficult to reach.

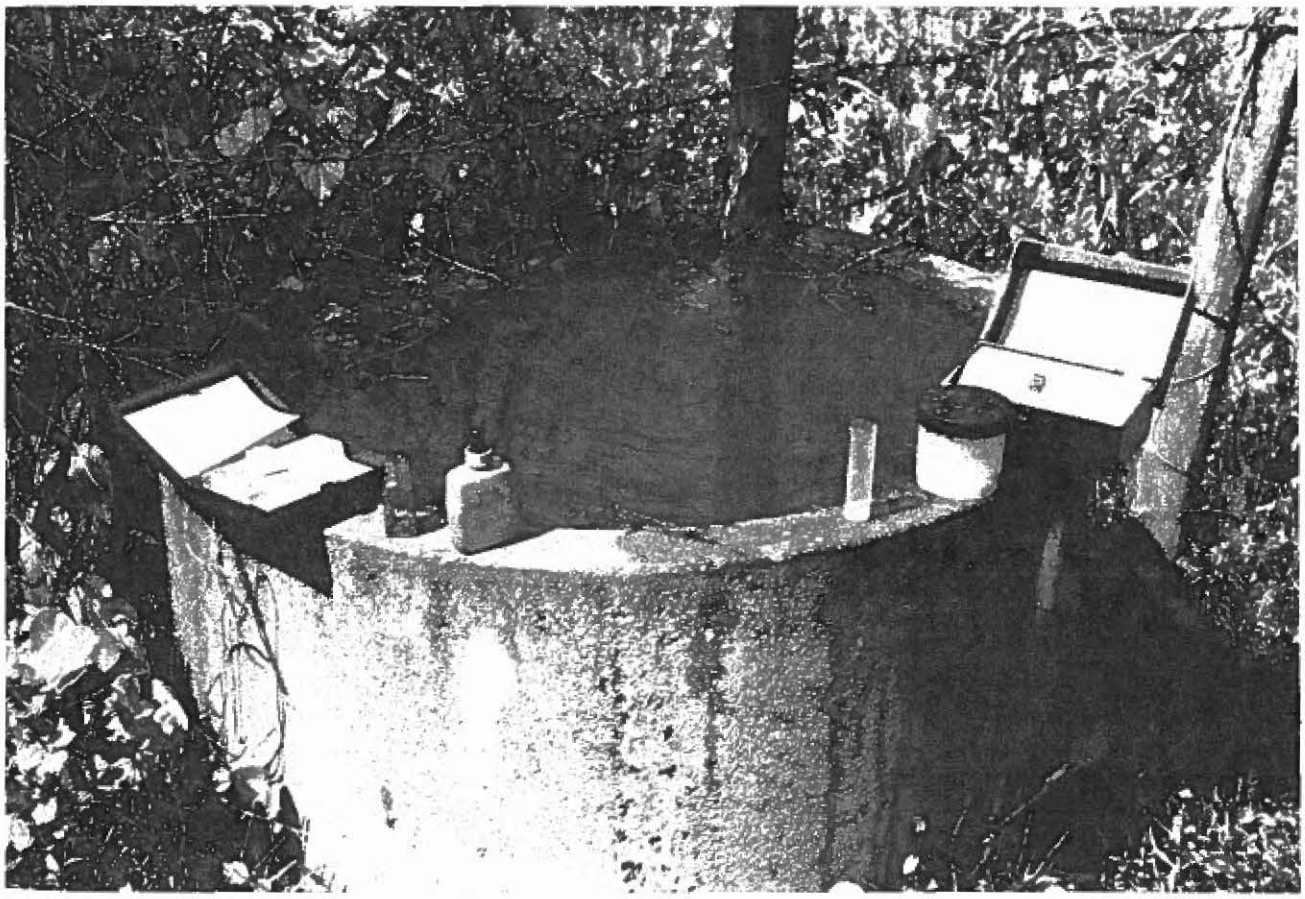
Ten kilometers north-northwest of Columbus on the H. R. Cullen estate are **Brune Springs (5)**. Here Ludwig Brune settled in 1847. A cotton gin once used the water. In 1978 0.05 lps seeped from Willis sandstone and sand among water pennywort. According to Thurman Brune, who knew the springs as a child, the flow was stronger then. The water formerly flowed into a small pond whose dam has now failed. Large cedar trees and live oaks draped with Spanish moss shade the site, where armadillos search for ants. A windmill well pumps water about 100 meters south.

Eleven kilometers east of Ellinger, partially on W. L. Mrkwa's ranch, are **Gayda Springs (6)**, which feed Gayda Branch. Gayda Branch discharged 0.45 lps from Willis gravel at the county road crossing on April 20, 1978. Smaller springs maintain a small pond fringed with pennywort and water primrose and containing bass, on Mrkwa's ranch. Many seeps and bogs occur in this vicinity. Mrkwa states that the springs flow more just *before* a rain. This phenomenon is due to the lowered atmospheric pressure which usually precedes a storm. Bluebonnets paint the surrounding fields blue in spring.

Boggy Springs (10), which feed Boggy Creek, are five kilometers north of Frelsburg on Arthur Hartfiel's farm. They were formerly a popular fishing spot, and a few small perch still survive among the pennywort in the creek. Hartfiel, who used to drink the water while plowing, says the springs have not failed since 1900. On April 21, 1978, they discharged 2.7 lps from Fleming sand at the road crossing south of Hartfiel's house, at an elevation of about 107 meters. Many cedar trees grow in the calcareous sand nearby, and bluebonnets and evening primroses adorn the fields.

Kessler Springs (3) are eight kilometers northeast of Columbus on Mrs. Florence Zajicek's property. Many projectile points found here indicate that this was a popular place long before Europeans arrived. From 1870 to 1888 Henry Kessler developed a well-known health spa here, according to information furnished by Mrs. James Hopkins, chairperson of the county Historical Survey Committee. He built a hotel and lake at the

Kessler Springs with water-quality testing equipment.



springs and a road to Alleyton. Sulfur-water baths were offered as well as mineral water for drinking purposes. Freshwater springs were also used. The clean sand-bottomed lake was used for swimming and fishing. Some of the guests hunted deer, bears, and ducks. A vineyard supplied a wine which gained a state-wide reputation for its excellence. Stagecoaches made regular stops here.

All of the buildings at Kessler Springs later burned and the lake, which was becoming filled with mud, was drained. In 1978 the springs poured out 0.71 lps from Willis gravel and sand among pennywort, ferns, palmettos, and soft rushes. Field tests show the waters to be entirely fresh now, although they have a slight oily film. The springs form a swampy area on Gabriel Long Branch in which cattle sometimes bog down. Water snakes and crawfish are numerous in the wooded area. Many other springs gurgle nearby.

Alleyton Springs (4) are one kilometer east of Alleyton on Highway 102, originating on the adjacent D. W. Harrison ranch. The springs were formerly walled up and made a very convenient water stop on the highway for people and horses. Margaret Griffith of Alleyton used to stop here for water as a girl around 1913. The springs poured from terrace gravel at 0.75 lps in 1978. Numerous gravel pits surround the site. The pools, shaded by cottonwood trees, contain yellow irises and water primroses. (See Plate 11, b).

McCroskey Springs (8) are four kilometers east-southeast of Alleyton on Howard Schindler's ranch. Here John McCroskey had a tannery in early days. Some of the springs contained sulfur and were valued for health purposes. They flowed from Willis sand on clay, but are now dry. A well which later pumped at the site has also been abandoned. Much gully and bank erosion has taken place along Mineral Branch, into which the springs ran. Its lower end is completely choked with sand.

Alley Springs (15) are seven kilometers southeast of Alleyton on R. M. Fitzgerald's ranch. La Salle's party may have paused here in 1687. Nearby, marked by a monument, is the site of Abram Alley's 1823 cabin. In 1978 springs poured 1.1 lps from Beaumont sand and gravel among pennywort in a ravine one kilometer south of the cabin site. In 1823 the Colorado River probably flowed in a channel 100 meters west of the cabin, according to Alfred Hoffman, who manages the ranch. Springs probably flowed along the river banks then, when water tables were much higher. A well dug later near the cabin now has a water table 8 meters below the surface. Deer and cattle egrets are numerous. Many Indian artifacts have been found one kilometer north of the cabin site.

Three kilometers southeast of Garwood on Leo Hoelscher's ranch are some seeps (9) which maintain a constant water hole in a pasture. When this area was settled in 1836, there were probably good springs here. In 1978 they seeped 0.03 lps from Beaumont sand.

Twelve kilometers south of Columbus on William Miekow's land, leased by Lester Cranek, were **Harbert Springs (2)**. Jonathan Dalrymple settled here in 1830, no doubt attracted by the springs. They still trickled 0.13 lps in 1937 from Lissie gravel. Later the springs probably failed, as a windmill well was installed. Now the site is beneath a lake. Many deer and other wildlife frequent the area.

Ten kilometers southeast of Weimar on Milroy Hoegemeyer's farm were some springs (14) which gave their name to Spring Branch. Now they are only seeps from Willis sand. Wine cups and golden wave adorn the adjacent fields.

Eight kilometers east of Weimar on Margaret Griffith's property are some springs (13) which feed the South Fork of Harvey Creek. They emerge from Fleming sandstone just across Highway 90 from the Borden Country Club, a beer emporium in the Borden community. The 1978 flow of 0.25 lps was fringed by water pennywort. About four kilometers downstream on the E. H. Rabel farm the sandstone has been carved by the water to form **Clear Hole** and **Blue Hole**. These holes were very popular for swimming until the 1930s.

Osage Springs (11) are eight kilometers northeast of Weimar on Truman McMahan's property. Indian artifacts indicate that this was a favorite haunt of an ancient people. A granite monument marks the site of Old Osage, a community which grew up around the springs in the 1850s. According to Oscar Addicks, a nearby neighbor, a cotton gin and hotel once used the water. In 1978 the springs trickled 0.15 lps from Fleming sandstone which dips toward the south or upstream, and fed a small pond. They are now about 200 meters northwest of the monument. According to Addicks, the flow was formerly stronger. Originally the springs probably flowed at a higher elevation, about 100 meters west of the monument on the state campground. Many bluebonnets and scarlet paintbrushes fill the surrounding fields in spring.

Burnham Springs (12) are ten kilometers northeast of Weimar. In a steep ravine adjacent to the Colorado River, they emerge on Henry Brasher's property. Here Jesse Burnham established his ferry and trading post in 1824. A monument two kilometers southwest commemorates the site. In more recent times the springs have been used by fishermen. On April 21,

1978, 0.05 lps seeped from Fleming sandstone among ferns below some rock outcrops, sinking into sand before reaching the river. In the past, with a higher water table, there were probably springs above the rock outcrops also, which formed waterfalls. Many similar very small springs trickle in the adjacent bluffs.

COMAL COUNTY

Most of the springs in Comal County issue from Lower Cretaceous limestones, chiefly the great cavernous underground reservoir of the Edwards and associated limestones. These formations dip to the southeast at about three meters per kilometer. Passing through the county from southwest to northeast is the 25-kilometer-wide Balcones fault zone, which extends from Del Rio to Waco. Along these faults the rock formations have been displaced as much as 200 meters, with the downthrown side on the southeast. This has often placed impervious rocks such as the Taylor shale on the southeast against the cavernous Edwards limestones on the northwest. In effect an underground barrier was formed, forcing the ground water in the Edwards aquifer to rise through the fault fissures and appear as springs. A few smaller springs also issue from terrace gravel in the southeastern part of the county.

The large springs have been favorite camping places of the Tonkawas and their predecessors for many thousands of years. When Domingo Teran and Fray Damian Massanet arrived in 1691, they found a huge concentration of Indians at Comal Springs, some from as far away as New Mexico and Parral, Mexico.

Comal is the Spanish word for *basin*. It probably refers to the bowl-like valley surrounding Comal Springs. The Comal River, five kilometers long, is one of the shortest rivers in the country.

In modern times the springs and spring-fed Guadalupe River rank among the most popular recreational spots in Texas. Canoeing, rafting, and riding inner tubes down the rapids are favorite sports. Many swimmers flock to century-old Clemens mill dam in New Braunfels, where tubers can race down the fast, S-shaped chute. (See Plate 3, a).

Spring flows have decreased to some extent in historic times. The decrease has been more noticeable in the small springs flowing from Glen Rose limestone and terrace gravel than in the large Edwards limestone springs. The Edwards has a remarkable ability to recharge itself when runoff water is available. Still, it was a great shock to the world of groundwater hydrology when Comal Springs, the largest in Texas, dried up in 1956.

Many plants and animals depend upon the springs for their lives. If the springs fail, most of this flora and fauna will disappear. Some species live only at springs in Comal County.

The spring water is generally of a calcium bicarbonate type, fresh, very hard, and alkaline.

Most of the writer's field studies were made during the period November 13-18, 1978.

One of the earliest mentions of **Comal Springs (29)** was that of Massanet (Ximenes, 1963):

> We stopped on the banks of the creek [Comal River] which flows into the river [Guadalupe]; the village was within the woods. Today we traveled five leagues and I named this site **San Gervacio** because we left it on his day. In the language of the Indians it is called **Conaqueyadesta**, which means "where the river has its source."

Espinosa's diary of 1716, when he accompanied the Domingo Ramon expedition, provides a more detailed description (Tous, 1930 b):

> Soon we reached the passage of Guadalupe which is made of gravel and is very wide. Groves of inexpressible beauty are found in this vicinity. We stopped at the other bank of the river in a little clearing surrounded by trees, and contiguous to said river. The waters of the Guadalupe are clear, crystal and so abundant that it seemed almost incredible to us that its source arose so near. Composing this river are three principal springs of water which, together with other smaller ones, unite as soon as they begin to flow. There the growth of the walnut trees competes with the poplars. All are crowned by the wild grapevines, which climb up their trunks. They gave promise already in their blossom for the good prospect of their fruit. The white and the black mulberry trees, whose leaves were more than eight inches in length, showed in their sprouts how sharp were the frosts. Willow trees beautified the region of this river with their luxuriant foliage and there was a great variety of plants. It makes a delightful grove for recreation, and the enjoyment of the melodious songs of different birds. Ticks molested us, attaching themselves to our skin.

In 1845 a group of German immigrants under Prince Carl of Solms-Braunfels settled here, calling the springs **Las Fontanas**. They purchased the 525 hectares surrounding the springs for $1,111. By 1860 seven grist, flour, and sawmills were using the spring waters for power. Cotton and woolen factories, a paper mill, an ice plant, and a brewery also utilized the water. An 1868 *Map of New Braunfels* showed a large swamp downstream from Comal Springs. It has now largely been drained. In early days it was necessary to carry water from the springs. In 1870, according to Oliver Haas, water expert for Comal County, a water works using the spring water was developed for the Landa community, followed by a water system for New Braunfels in 1886.

In 1890 the Landa electric light plant began operations. Hydro-electric power was generated until about 1950. A new hydro-electric plant is now (1978) being readied for a resumption of water-power generation by

the city of New Braunfels.

Comal Springs burst under artesian pressure from the Comal Springs fault over a distance of 1,300 meters at the base of a high bluff, at an elevation of 190 meters, forming Landa Lake. The accompanying map shows the location of the various springs. The "three principal springs" described by Espinosa were probably springs j, k, and l. Spring l is the largest of the Comal Springs. Here in 1756 the mission Nuestra Senora de Guadalupe was established for the Mayeye Indians. Because of frequent raids by the Comanches, it was abandoned in 1758. Another large spring (b) breaks out from a deep hole beneath the surface of the lake.

Landa Lake has largely been filled with gravel brought down by man-made floods in upstream Blieders Creek. Most of the remaining springs issue through this gravel. Their locations are usually marked by bubbles, and also by schools of fish which congregate around the springs. Additional medium to very small springs issue from terrace gravel on Dry Comal Creek (o), at Landa Resort (p and q), and opposite the Other Place (r). All except spring r are included in the discharge measurements made by the U. S. Geological Survey. Discharge records in liters per second by water year are as follows:

1882	10,600	1941	9,200
1885	11,100	1942	9,500
1896	9,300	1943	10,300
1897	11,000	1944	9,700
1898	8,600	1945	10,100
1899	8,800	1946	9,700
1900	10,200	1947	10,600
1901	10,200	1948	8,200
1902	9,200	1949	7,900
1903	11,700	1950	7,700
1904	10,600	1955	2,900
1905	11,000	1956	1,400
1906	10,900	1957	3,900
1910	8,500	1958	8,500
1911	7,600	1959	9,100
1915	11,500	1960	9,000
1921	9,100	1961	10,000
1924	10,500	1962	8,200
1925	9,100	1963	6,300
1926	8,500	1964	5,300
1927	9,100	1965	7,400
1928	8,200	1966	8,000
1929	8,100	1967	5,300
1930	8,000	1968	9,200
1931	8,800	1969	8,300
1932	9,000	1970	8,800
1933	8,900	1971	8,900
1934	8,900	1972	10,100
1935	8,800	1973	10,500
1936	10,100	1974	11,300
1937	10,100	1975	12,000
1938	9,600	1976	10,400
1939	8,900	1977	11,800
1940	8,000	1978	9,300

The average flow has been 9,000 lps. Maximum recorded instantaneous discharge was 15,100 lps on October 16, 1973. There was no flow from June 13 to November 3, 1956. The flow has fluctuated since 1927 because of seasonal withdrawals from wells.

The springs water is always remarkably clear, indicating that it comes from considerable distances with much opportunity for straining and purification. The recharge area lies as much as 100 kilometers west. Here rainfall and stream flow enter sinkholes and cavities especially where faults cross the creeks. Entering the Edwards limestone, the water travels eastward and east-northeastward, moving much of the time along passages formed by faults in the rocks. According to George (1952), Comal Springs reach a peak flow one or two months after a rain in the recharge area.

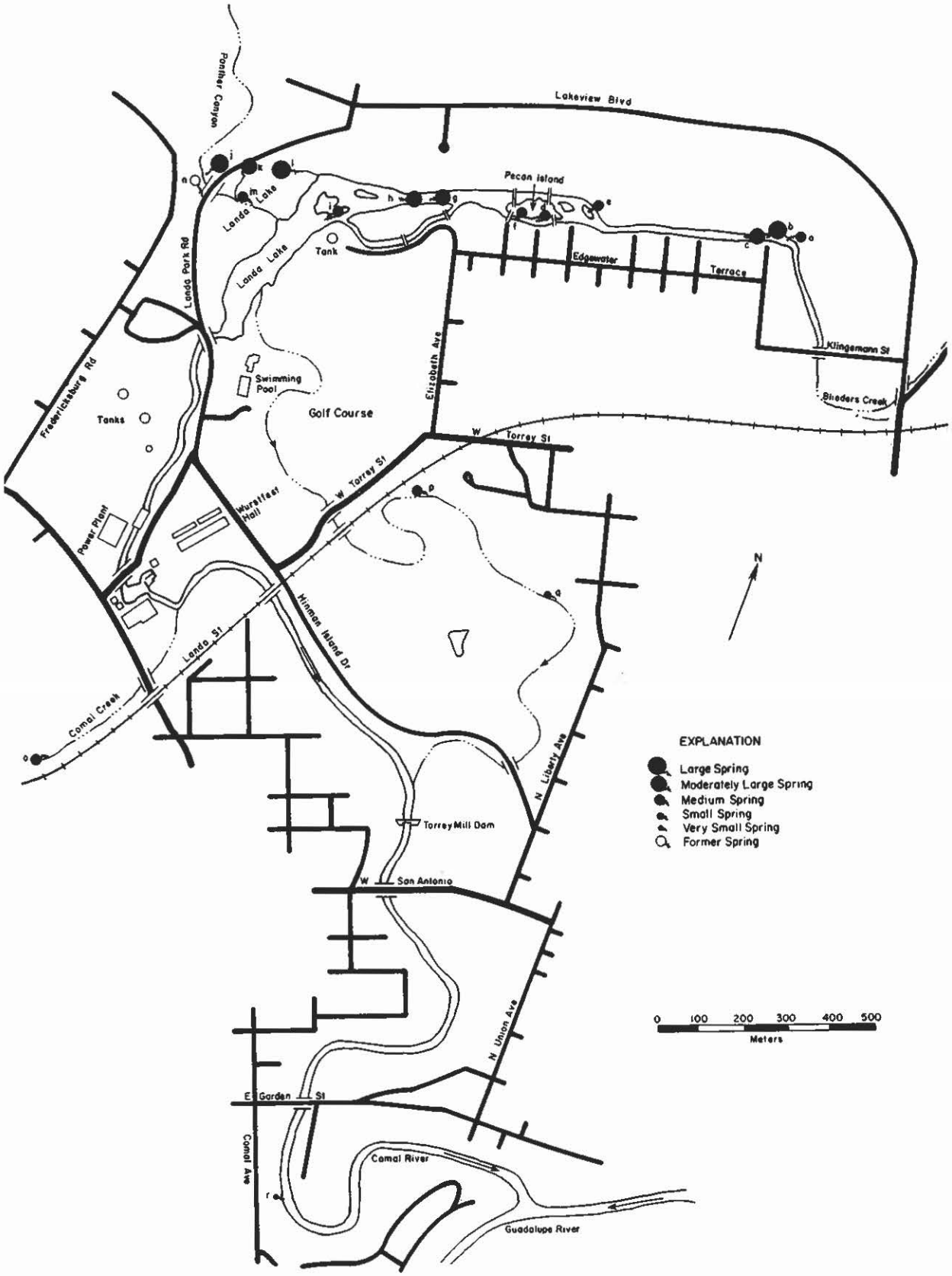
According to Guyton and Associates (1979), Comal Springs can be expected to dry up again, even in the absence of a major drought such as occurred in the 1950s. Withdrawals from wells are slowly approaching the average recharge. In time little or no water will be left to spill from the underground reservoir through the springs.

The spring water has a temperature ranging from 23.1° to 23.9° Celsius, or about 3 degrees higher than the average annual air temperature at New Braunfels. Because the temperature of ground water increases with depth, this suggests that the water circulates through depths as great as 150 meters below the surface before reaching the springs.

The dissolved solids in the Comal Springs water average about 285 milligrams per liter. Using an average discharge of 9,060 lps, George computed that 2 tons (181 metric tons) of rock material is carried away daily in solution by the spring waters. About 0.6 milligram of strontium per liter, 0.1 mg/l of boron, and lesser amounts of copper, mercury, and zinc have been found in the water. Tests show that nutrients, bacteria, insecticides, and herbicides have not entered the water to any serious extent. But care will be required to prevent polluted water from entering the aquifer in the recharge area.

A species of amphipod, also called a scud or sideswimmer (Stygonectes pecki) has been found only in Comal Springs. This species depends for its existence on the maintenance of the springs' flow.

Altgelt Springs (4) are near the intersection of Wald Road and Loop 337 in southwest New Braunfels on E. R. Teinert's property. They are unusual in that they issue from a reversible or resurgence sinkhole. Normally there is a flow from the sinkhole, which contains much milfoil. But in times of low water the surface water flows into the sink. On December 1936, the fresh water was reported to be flowing 3 at a depth of 14 meters in the sinkhole, which was meters deep. On November 18, 1978, the disch



Location of the various Comal springs.

from the sinkhole in Austin chalk, was 1.6 lps. The pool has been pumped at 44 lps for irrigation.

Ten kilometers southwest of Spring Branch on John Gaas' ranch are **Honey Springs (22)**. The springs issue from a cavern near the base of the Glen Rose limestone. St. Joseph's church, now four kilometers south, was located here in 1876. The Honey Creek Cave blind salamander is known to exist only at these springs. On July 20, 1944, the discharge was 63 lps, and on August 18, 1970 it was 23 lps.

Magic Springs (21) are five kilometers northwest of Spring Branch on Walter McAllister's ranch, managed by Wilson Blackburn. They pour from a cavern at the base of the massive Glen Rose limestone. The cavern has been explored 100 meters to the northeast, where an irrigation well penetrates it. Walks and stairways lead down the bluff to the springs. The water cascades over numerous falls, forming small travertine dams across the creek and coursing through fish-filled pools. Water cress, water pennywort, water lilies, elephant ears, palmettos, and maidenhair ferns adorn the rocks and pools. The site is shaded by live oaks and cypress trees draped with much Spanish moss and ball moss.

Some water disappears in a sinkhole a short distance below the springs, to reappear in other springs downstream. The water is used by the ranch buildings, formerly pumped by a hydraulic ram but now by an electric pump. Another hydraulic ram formerly pumped water from the creek downstream to the Spring Branch community. The following discharge records, in lps, are for Spring Branch where it enters the Guadalupe River five kilometers south-southeast of Magic Springs:

Aug. 1924	99	Oct. 1951	14
Jan. 1928	43	Jan. 1955	28
Feb. 1929	25	Mar. 1962	40
Feb. 1930	28	Aug. 1970	156
Nov. 1936	51	Nov. 1978	51
Mar. 1945	311		

At the time of the November 1978 observation, 42 lps were flowing from Magic Springs and the remainder from other springs downstream.

Rebecca Springs (23) are six kilometers northeast of Spring Branch in the Cypress Lake Gardens community. The water is used as a municipal supply. The springs discharge from fissures and solution cavities in the Cow Creek limestone. The pools contain much milfoil and many fish. (See Plate 1, b.) Overhead are cypress trees draped with Spanish and ball moss. Discharge records in lps at the Park Drive crossing are:

Oct. 1925	11	Aug. 1970	31
Oct. 1943	110	Nov. 1978	13

Eight kilometers east-northeast of Spring Branch were **Wolle Springs (24)**. They pour from fissures in the Glen Rose limestone. The water was muddy during upriver rises, leading to the belief that the aquifer was fed by the Guadalupe River upstream. In 1944 the discharge was 420 lps, and on January 26, 1955 it was 620 lps. In 1964 the springs were covered by Canyon Lake. They were also called **Jentschquelle**, according to Paul Jahn of New Braunfels. *Quelle* is German for *spring*.

Bishop Springs (37) are near Crane's Mill, eight kilometers south-southwest of Fisher. They issue from large cavities in the Glen Rose limestone. They include **Flugrath, Gumtree**, and **Big Springs**. According to Walter Flugrath of New Braunfels, a cotton gin used the fresh water from about 1920 to 1935. Although now under about 23 meters of water in Canyon Lake, the clear spring water can still be seen, surrounded by murky lake water. Fish tend to gather here. Discharge records in lps follow:

Aug. 1924	210	Aug. 1951	2.8
Jan. 1928	110	Oct. 1951	8.5
Feb. 1929	82	Sep. 1952	23
Nov. 1936	91	Mar. 1962	260
Jan. 1938	110		

Ten kilometers south of Fischer are two moderately large springs (25), also covered by Canyon Lake since 1964. They pour from crevices in the Glen Rose limestone where the Tom Creek fault crosses the Guadalupe River bed. Discharge records in lps include:

Sep. 18, 1944	400	Mar. 7, 1962	260
Jan. 27, 1955	230		

Like Bishop Springs, they can still be seen and provide excellent fishing.

Fischer Springs (1) are one kilometer northeast of Fischer store on Walter Fischer's ranch. The fresh water issues from Glen Rose limestone in a depression surrounded by Spanish-moss-draped live oaks. The springs supply the Fischer house with water. An unused windmill stands nearby. On November 4, 1936, the discharge was 3.8 lps. On September 13, 1943, there was no flow. On November 17, 1978, the flow was 0.30 lps.

Six kilometers southeast of Fischer on Sorrel Creek are **Sorrel Springs (2)**, partly on Lucille Downing's property. On December 31, 1936, they produced 6.3 lps of fresh water from five openings in Glen Rose limestone, only one of which was reported to flow the year around. On November 17, 1978, the discharge was 1.6 lps. Cedars and live oaks shade the site.

Eight kilometers southwest of Sattler on Alfred

Liebscher's property are **Bear Springs (26)**. They surge from Edwards limestones along the Bear Creek fault, and reportedly have never failed. During the Civil War, according to Mrs. Liebscher, bushwhackers or Union sympathizers hid out near here. The springs feed a small pond which is fringed with willow and sycamore trees and maidenhair ferns. Much travertine has been deposited where the spring flow enters Bear Creek. Discharge records in lps are:

Sep. 29, 1943	11	Sep. 29, 1945	11
Mar. 28, 1945	140	Nov. 18, 1978	13

Buffalo Springs (3) are six kilometers south of Sattler on Layton Leissner's ranch. The water seeps from vugular Edwards limestone in a wooded rocky ravine. The flow has built small travertine dams across the creek. It runs through a pool fringed with maidenhair and other ferns and disappears among boulders. Deer are numerous. Several Indian middens and numerous projectile points found here disclose that this has long been a popular site. Settlers arrived here in the 1840s. C. W. Pressler depicted the springs on his 1858 *Map of the state of Texas*. On November 18, 1978, the discharge was 0.48 lps.

Hueco Springs (28) are seven kilometers north of New Braunfels near the junction of Elm Creek and the Guadalupe River on Judge Robert Pfeuffer's property. *Hueco* is the Spanish word for *hollow*. It is sometimes spelled *Waco* or even *Huaco*. Indians lived here for thousands of years, departing in 1846 on the arrival of the colonists in New Braunfels, and leaving behind the lodgepoles of their wigwams. Many doubtless lived also in the numerous rock shelters in the adjacent limestone bluffs. The water was long used to power a mill. Until 1948 a hydro-electric plant supplied power for Huaco Springs lodge, now Judge Pfeuffer's residence. (See Plate 14, d).

There are two main groups of springs, one on each side of the river road, which issue under artesian pressure from Edwards limestone at the Hueco Springs fault. The southeast springs begin to flow when the flow at the northwest springs reaches 710 lps. The discharges of the two outlets become nearly equal in the high range of their discharge. At the southeast springs the water bursts through alluvial cobbles at the base of a sycamore tree at around 200 meters elevation. Water cress is abundant and ferns drape the old mill dam. Discharge records in lps by water years are as follows:

1924	1,000	1960	1,400
1928	0	1961	1,500
1929	0	1962	370
1937	42	1963	590
1944	1,700	1964	480
1945	1,600	1965	1,400
1946	1,500	1966	2,000
1947	1,600	1967	650
1948	200	1968	2,300
1949	1,300	1969	1,400
1950	760	1970	1,400
1951	14	1971	570
1952	280	1972	2,000
1953	1,200	1973	1,700
1954	71	1974	1,900
1955	0	1975	1,700
1956	0	1976	1,500
1957	1,200	1977	2,200
1958	2,300	1978	790
1959	1,800		

The maximum recorded discharge was 3,710 lps on January 21, 1968. Temperature, turbidity, and discharge all fluctuate with rainfall, indicating that the recharge area is relatively small and nearby, chiefly within the Dry Comal Creek and Guadalupe River basins. When the writer visited the springs on November 18, 1978, following rains, the water was quite murky. The average annual discharge has been 1,100 lps.

In addition to the constituents shown in the table of Selected Chemical Analyses, the water contains about 0.3 milligram of strontium per liter, 0.04 mg/l of boron, and lesser amounts of zinc and nickel. Tests show that contamination by nutrients, bacteria, insecticides, and herbicides has not been serious to date. It must be guarded against in the future, however.

Gruene Springs (5) are four kilometers northeast of New Braunfels in the old village of Gruene. Issuing from a high bluff of terrace gravel on the east bank of the Guadalupe River, they are on R. O. Van Horn's property. Many flint projectile points have been found in the vicinity. A gravel pit is just east of the springs, across the road. The fresh water is used in the Van Horn home. Discharge records in lps are:

Dec. 30, 1936	3.8	Nov. 18, 1978	0.52
Sep. 29, 1943	1.6		

COOKE COUNTY

The springs of the county issue chiefly from Upper and Lower Cretaceous sands, sandstones, and limestones and from river terrace sands. Groundwater levels have declined seriously, because of well pumping, and many springs have consequently failed.

Most of the creeks flowed throughout their length in the nineteenth century. Stories of swimming and boat-

ing in them abound. In 1883 the spring-fed Elm Fork was dammed to supply Gainesville with water. But the springs soon began to fail, and in 1894 a flowing well was drilled.

The Lower Cretaceous Antlers sand is very susceptible to erosion. Plowing and overgrazing of this land caused huge gullies to develop. The eroded sand was dumped downstream, choking stream channels and burying some springs.

Most of the writer's field studies were made during the period October 10-15, 1977. As the preceding several months had been very dry, the spring discharges observed are probably below normal for this season.

The water is generally of a sodium bicarbonate type, fresh, very hard, and alkaline. The content of sulfate or fluoride may be high.

Camp Springs (4) are just east of Bulcher on Camp Creek. In 1860 the creek flowed "clear running water" throughout its length, supporting much fish and game. Now the springs survive only near the creek's mouth, where the discharge in 1977 was 1.0 liter per second. Minnows and whirligig beetles play in pools fringed with horsetail.

Eight kilometers east of Bulcher, on Raymond Davidson's ranch, are **Pecan Springs (5)**. Well known in early days, they seeped only 0.03 lps from Lower Cretaceous sand in 1977. Pecan trees are still numerous around the small pond supplied by the seepage.

Fish Springs (6) were on Fish Creek near Mossville, 17 kilometers northwest of Gainesville. Now Mossville and most of the springs are beneath Moss Lake, formed in 1966. According to Clayton Krause who operates a marina at the lake, several springs are near the dam, under as much as 14 meters of water. Fish gather near the springs because of the oxygen in their water. Below the dam, on the south side, are more springs. According to Johnnie Perry, a nearby resident, these springs were here before the dam was built, but they have no doubt been strengthened by leakage from the lake. On October 12, 1977, 1.0 lps of iron-rich water seeped from Antlers sand.

Cox Springs (7) are 13 kilometers north of Callisburg in the Coesfield community, on the C. L. Wooten ranch. At this place many women gathered to do their washing in the 1860s. Three men are said to have been hanged from an oak tree here for horse stealing. But other sources say this hanging occurred at Davidson Springs in the southwest part of the county. In 1977 several springs produced 1.3 lps from the Lower Cretaceous Weno limestone. Of this, 0.05 lps reached Lake Texoma, two kilometers downstream.

Dripping Springs, which formerly dripped from limestone two kilometers north-northwest of Cox Springs, are now beneath Lake Texoma. In the 1860s swimming in Rock Creek, a few kilometers east, was a popular sport.

Three kilometers northeast of Callisburg on Joe Wilson's ranch are **Tartar Springs (16)**. An Indian campground was situated here. Later there was an old log school, and in the 1870s a church was 0.5 kilometer southwest. The springs are now partially beneath a stock tank, bordered with pennywort and swamp grass. Seeps occur also on the adjacent J. M. Hollandsworth ranch. After much dry weather on December 22, 1977, 0.20 lps issued from Woodbine sand at Tartar Springs. They are marked by orange iron oxide and white salt incrustations, amid many sandstone boulders.

Brothers Springs (8), probably the largest in the county, are four kilometers south of Callisburg on Mrs. Joe Wyatt's ranch. The Brothers cemetery and Spring Grove school were nearby. This was a stage stop on the old Butterfield trail. Now a relatively constant discharge of around 1.5 lps from Woodbine sand at an elevation of 245 meters supplies a series of five ponds. Pink canelas, purple asters, and marsh purslane decorate the site.

Spring Grove Springs (9) are 11 kilometers east of Gainesville on Mrs. Edgar Stanley's property. In the 1860s a Mr. Pollard built a log cabin here, according to nearby resident J. R. Nelson. A cotton gin later used the water. From 1917 to 1926 J. M. Hollandsworth, who lives in the area, carried water to the Spring Grove school. Now there are only seeps in a grove of willows and cottonwoods.

Twelve kilometers east-southeast of Gainesville, on E. L. Cunningham's ranch, are **Indian Springs (10)**, which feed Indian Creek. Many Indian artifacts have been found here. In 1788 Pedro Vial probably stopped here en route from Santa Fe to Natchitoches. According to Mr. Nelson, an early settler by the name of Bush built a double log cabin here. Now the springs are only underwater seeps into a pond edged by willows, cottonwoods, and cedars. The pond does not normally overflow, but maintains a constant level. On October 13, 1977, the amount of seepage required to offset net evaporation was estimated to be 0.11 lps. Other small springs are nearby.

One-half kilometer southeast of Indian Springs, also on the Cunningham property, are **Bluff Springs (17)**. Located beneath a bluff of Woodbine sandstone, the water seeps into Lake Kiowa just downstream on Indian Creek. In 1862, when 40 Union sympathizers were hanged at Gainesville, Joel de Lemeron, a Union

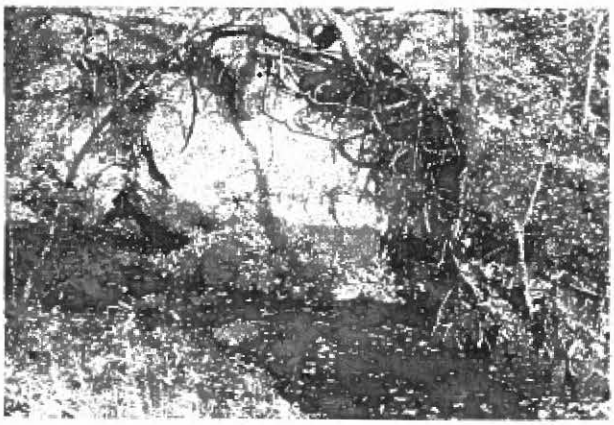
sympathizer, lived at these springs. He was tried and sentenced to life imprisonment. In the 1920s the spring water flowed from large crocks, according to Nelson. the springs have now been partially buried under sediment from accelerated erosion. On December 22, 1977, there were only seeps into pools. The pool water was black, probably from organic matter.

Mountain Springs (11) were 11 kilometers east-northeast of Valley View, on the old Bond place. Here "springs of crystal-clear and cold water" ran near Mr. Burch's home in the 1850s. Little Wolf Creek, fed by the springs, ran through the Mountain Springs community (now Burns city) to Wolf Creek. The place became a popular resort, with a hotel and other facilities. Now the channel is choked with sand, but there are still a few pools of live water. The Mountain Springs community later moved four kilometers south of the springs.

Six kilometers southeast of Gainesville, on Fulton Murray's ranch, were **Fitzhugh Springs (1)**. They served the small settlement at Fitzhugh's Fort in 1847, and a Pawnee village much earlier. They once flowed from Lower Cretaceous vugular limestone in the bluff west of the fort, on the east side of Elm Fork, but have long been dry.

Valley View Springs (12) were just west of Valley View on Spring Creek. In 1872 as many as 50 wagons and teams were drawn up around the springs at times. Jimmy Nichols, the Chevrolet dealer, remembers the springs at the old bridge west of town, where swimming and outings were popular. The springs issued from Lower Cretaceous limestone, but have been dry for at least 30 years. Many flowing wells drilled in the vicinity probably hastened the springs' demise. Numerous other springs flowed in the past in this vicinity, on Spring, Willow, Indian, and Little Indian Creeks.

Cove Springs (14) are 14 kilometers southeast of Forestburg in a wooded, hilly area. According to W. B. Inglish of Rosston, large Indian villages were once located at these springs. Now there are only seeps from Antlers sand among Goodland limestone rock shelters. As at many other similar locations, there are rumors that Sam Bass hid out here and buried some gold.



Bluff Springs.

Nine kilometers west of Era, on the Holcomb estate, are **Davidson Springs (13)**. A double log cabin once stood here, according to Tom Inglish of Rosston. The springs, which fed Williams Creek, furnished water for a stage stand on the Butterfield trail. Some seepage from Antlers sand and gravel still collects in pools of standing water.

Big Springs (2) are two kilometers south of Myra, on Emmet Sicking's ranch. In 1863 Indians raided the Shannon farm here. A sycamore tree grew at the springs then, but has now been replaced by pecans. Many early settlers hauled water from these springs. In 1977, 0.18 lps came out of gravel to feed two stock ponds containing fish.

Twelve kilometers southwest of Muenster, on Mrs. Roy Kingery's property, are **Rour Springs (3)**. In the 1860s both the William Pitman and Henry Rour families used these springs. A disagreement arose between them, Pitman shot and killed Rour at the springs, and was hanged for the crime. The very small springs still drop from a bluff of Lower Cretaceous limestone.

COTTLE COUNTY

The fresh-water springs of Cottle County issue chiefly from Quaternary windblown sand deposits and river terrace sand and gravel. Some springs containing water that is high in sulfate content trickle from Blaine gypsum, Whitehorse sandstone, and other Permian formations. The very saline springs and seeps, whose water is high in sodium chloride, originate chiefly in the Permian Dog Creek shale.

Archeological sites where prehistoric people once lived are scattered throughout the county. At these sites there must have been fresh or slightly saline springs or spring-fed creeks. Many have dried up in modern times because of man's activities.

The spring water is generally of a calcium sulfate type, slightly saline, very hard, and alkaline. The sulfate content (from gypsum) often causes diarrhea in humans and may be so high that livestock will not drink the water. The brine springs, which discharge water saltier than sea water, present a problem of contamination of downstream water supplies. Plans are being prepared for the control of these springs.

Most of the writer's field studies were made during

Mill Iron Springs.

the period July 9-15, 1979. As about eight centimeters of rain fell on most of the county during the preceding two weeks, the observed spring discharges are probably higher than normal for this season.

About one kilometer northwest of the old Mill Iron ranch headquarters at Cee Vee are **Mill Iron Springs (3)** on W. T. Timmons' ranch. In 1890 these springs, which feed Richland Creek, were much frequented by women from the surrounding area who washed clothes here. Edna Goodwin lived at the springs from 1902 to 1913. She played here and helped catch fish in a trap. At that time there were deep holes in Richland Creek, which ran the year around.

Now Richland Creek is largely filled with sediment. A series of pools were fed on July 15, 1979, by seepage from thick beds of Blaine gypsum. The seep areas were covered with a crust of white gypsum. Some former springs could be seen in openings in the gypsum bluffs. According to Timmons, the creek still runs in winter. Large cottonwood, willow, and chinaberry trees, plum bushes, and rushes thrive here.

In extreme northwest Cottle County on R. C. Elliott's ranch are **Joe Lake Springs (1)**. They still seep from a bluff of Permian gypsum and sandstone on Joe Lake Creek just south of Highway 94. Paleo-Indians are known to have frequented this vicinity. Elliott found a metate and many projectile points here. The springs stopped flowing continuously in the 1920s. Small minnows, water striders, and raccoon tracks may be seen at the willow- and salt-cedar-fringed pools. Three kilometers downstream on the north side of the North Pease River, according to Elliott, was formerly a salt spring whose water cattle could not drink. A seep still exists here.

Ten kilometers north of Cee Vee at the Hall County line is Running Water Creek (2) on the W. H. Tippett ranch. As its name indicates, it once ran constantly. On July 13, 1979, one week after a 13-centimeter rain, there was some seepage from beds and veins of gypsum into pools of clear water. Normally there is now seepage only in winter, according to Royce Tippett. Mud swallows' nests adorn the cliffs, while cottonwoods, willows, and salt cedars fringe the pools.

Sweetwater Springs (12) were twelve kilometers north of Dunlap on Jim Goundie's ranch. They were the source of once-flowing Sweetwater Creek. On July 15, 1979, there was a small amount of seepage from Blaine gypsum and sandstone into pools. Many cottonwoods and some willows fringe the channel, along with the usual mesquite and hackberry trees. Severe gully erosion has largely filled the channel. Indian living sites have been found nearby.

Three kilometers north-northwest of Dunlap are some springs (15) on Don Mahorney's ranch. Here an ancient people left projectile points and a metate. On July 15, 1969, 0.15 liter per second seeped from Quaternary sand and gravel on Whitehorse sandstone. The flow is stronger in winter, according to Mahorney. The creek channel has been largely filled with modern sediment. Cottonwood, chinaberry, salt cedar, and cedar trees and plum thickets shade the water. Three kilometers west is a similar very small spring on Mike Dickens' property.

On the Middle (13) and North Pease Rivers (14) there are numerous salt seeps along three-kilometer stretches, eight kilometers northeast and 16 kilometers north-northeast of Dunlap respectively. Those on the Middle Pease River are on Mrs. Sam Portwood's ranch, leased by Red Livingston. The water is reported to contain 10,000 to 20,000 milligrams of chloride per liter. In 1962 the discharge from both sources was estimated to be about 56 lps. Plans are being made to pump the saline water to Crowell Reservoir northwest of Crowell, where the water will be allowed to evaporate.

Owl Springs (11) were five kilometers east-southeast of Dunlap on the Fancher ranch, managed by Gerald Nunley. In 1789 Pedro Vial may have stopped here en route from San Antonio to Santa Fe. In 1858 an old road passed the springs en route to Foard City. Around 1920, according to nearby rancher J. T. Martin, Owl Springs were a favorite watering, fishing, and swimming hole. On July 15, 1979, there were only weak seeps from terrace gravel on Whitehorse sandstone. A windmill now steals the ground water. **Chittim Springs**, which still trickle weakly, are five kilometers northwest of Owl Springs.

Springs (8) flow four kilometers northeast o Paducah on Ronald Gilbert's lease. On February 19

1946, they discharged 0.13 lps. On July 13, 1979, the flow at Highway 70 was 1.6 lps. The water issues from Quaternary sand on Blaine gypsum into a series of pools. Much salt cedar, cattails, and cockleburs, and some willows and cottonwoods fringe the stream.

Eleven kilometers northeast of Chalk is an area of salt springs and seeps (10) on the Triangle ranch, leased by Willie Rushing. They are at the junction of Salt Creek and the North Wichita River, extending about four kilometers upstream and downstream on the North Wichita and the same distance upstream from the junction on Salt Creek. As shown in the table of Selected Chemical Analyses, the total-dissolved-solids content of the water is around 35,000 milligrams per liter. The seepage produces large areas of white, salt-encrusted soil. The discharge of all of the springs and seeps was 11 lps on November 28, 1951, from an elevation of 495 meters. In 1961 and 1962 it was estimated to average 56 lps. It is planned to pump the saline water to Crowell Reservoir, where it will be allowed to evaporate, trapping the salt.

The water of the salt springs issues from Blaine gypsum or Dog Creek shale, from which it leaches the salt. Recharge occurs through a cover of 10 meters or more of Quaternary sand in the area to the southwest. Removal of the salt has caused collapse of the rock formations in places. Tritium analysis indicates that most of the water is less than seven years old.

Otta Springs (9) are five kilometers northeast of Chalk on Homer Long's ranch. The springs start three kilometers upstream on the North Wichita River from Long's house. They become saltier downstream, but cattle drink the water. In 1886 J. L. Abbott was shot and killed at the springs. A post office and trading post were located here in early days. Until 1949, according to Long, there was a deep swimming hole in the creek. It has now been filled with sand.

Otta Springs are a series of springs and seeps which issue from terrace sand and gravel on cavernous Blaine gypsum at an elevation of 510 meters. On July 14, 1979, 71 lps were passing the Long house. The stream is fringed with willows, salt cedars, plum thickets, cattails, and rushes. Red-horse shiners and other fish are numerous, as are doves and quail. Raccoon and coyote tracks may be seen on the banks. According to Long, the water steams in winter. This is normal for most cold springs, whose waters maintain a temperature the year around one or two degrees Celsius above the mean annual air temperature.

On Buck Creek seven kilometers west-northwest of Chalk are a number of small springs (4) on Burnett Richards' ranch. **Buck Springs** issue from Blaine gypsum and sandstone. On February 20, 1946, the discharge was 1.3 lps. On July 13, 1979, after much rain, the flow was 4.7 lps. The water is moderately saline and high in gypsum (calcium sulfate). Cattle usually will not drink it.

Upstream on South Buck Creek, five kilometers north-northeast of Delwin, are more springs (5) on D. N. Gregory's ranch. Several Indian living sites have been found near here. Gregory formerly fished in the creek, but the holes are now filled with sand. A nearby shallow irrigation well saps the water, so that in summer there is usually no flow, but only pools of live water. In winter the creek runs as far east as Chalk. The recharge area is in the sand hills to the west, which overlie Whitehorse sandstone.

Five kilometers southwest of Delwin is Willow Creek (16) on Willie Gibbs' ranch, operated by Richard Gibbs. It was once a running stream, fed by springs from Quaternary sand and gravel. On August 8, 1979, there were a few seep-fed pools, but the channel had been almost completely filled with sand from modern erosion. Coyote tracks could be seen among the cockleburs and dead mesquite trees.

Clary Springs (7) are 17 kilometers west of Paducah on Dr. J. T. Westbrook's ranch. They flow from white river-terrace sand on Whitehorse sandstone beneath a cedar tree. In winter the water runs 1.6 kilometers to an earth tank, according to Westbrook. It is good drinking water although it contains some gypsum. Minnows, frogs, and ducks frequent the site.

Camp Hollow (6), 12 miles west of Paducah, still contains some wet-weather seeps. Very likely this was once a perennially running stream, fed from Quaternary sand hills and terrace sand. The channel is now largely filled with sand from modern erosion.

CRANE COUNTY

The springs of Crane County are nearly all things of the past. They flowed from lower Cretaceous limestones and sandstones along the Concho Bluff in the northeastern part of the county and on the slopes of Castle Mountain on the east side. They issued from Triassic sandstone along the Pecos River and at other places. Among the Sand Hills in the northwest part of the county the high water table produced many tree-shaded lakes in the past.

The springs were vital to native Americans, who usually camped near them. Evidence of these people includes Folsom points, perhaps 11,000 years old, associated with bones of mammoths and large bison which were hunted in those days. Burned-rock mid-

dens, pottery, metates, and stone tools have been found, usually near former springs and seeps, by Teddy Stickney, well-known Midland archeologist. When early Spanish explorers, such as De Sosa in 1590, passed through the county, they also made good use of the springs.

According to E. N. Beane of Crane, the Indians grew corn in areas of shallow water among the Sand Hills. Names such as *Coyote Well* suggest that in many places it was possible for coyotes and other animals as well as Indians to dig shallow wells to water. Cliff Newland of Crane remembers when water still stood in ponds among the sand dunes. Probably the last time this could be seen was in the 1920s. A lake south of Crane which was always full is now dry.

The oil industry has removed enormous quantities of groundwater for drilling, cooling, and other purposes. The Crane municipal well fields have also extracted large amounts. These and other factors have caused a great decline in the groundwater table, and are the primary cause of the disappearance of most of the springs.

The springs were once the site of a complex biosphere. Water cress, water lilies, cattails, and maidenhair ferns were shaded by willow and cottonwood trees. Fish, crawfish, turtles, snakes, and the larger animals which preyed upon them thrived in the springs' environment. Nearly all of these plants and animals have now disappeared along with the water. The scarce and endangered dune unicorn plant, known only from Crane County, seems destined to extinction. It requires a fairly shallow water table, which is rapidly disappearing.

The spring waters were generally of a calcium or magnesium bicarbonate type, fresh to slightly saline, very hard, and alkaline. The content of silica and fluoride was usually high. In some cases, as in the seeps around Cordona Lake, the water is very saline.

Most of the writer's field studies were made during the period December 3-8, 1978.

In northwestern Crane County, four kilometers southeast of the intersection of Interstate 20 and Highway 1053, is a draw where Quaternary caliche rests on Washita limestone. Here, on Robert McKnight's ranch, were probably once seeps (4) near the Old Headquarters windmills. There are many evidences of Indian camps in the vicinity. Now the site is covered with mesquite, sand sage, and yucca.

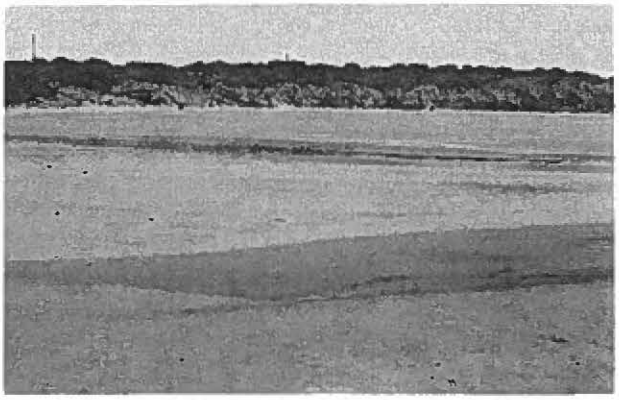
Six kilometers south-southwest of the intersection of Highways 385 and 1787 on John Baldwin's property is a native American living site. Here about 35 mortar holes have been ground into the Fredericksburg limestone on the Concho Bluff. A very small spring or seep (1) evidently flowed from this jointed limestone and was used by the people who lived here long ago. Some of the mortar holes have been destroyed by pipeline construction. Now the area is largely in creosote bush and catclaw.

Five kilometers southeast of this site is a similar one on Highway 385. Burned-rock middens indicate one-time living sites. Seeps or very small springs (3) once issued from the Fredericksburg limestone here also.

Fifteen kilometers west-northwest of Crane and four west of the Atlantic Richfield plant is a dry playa on University of Texas land. On the north side of the playa have been found a bedrock mortar, a burial, burned-rock middens, and flint projectile points, including a Meserve point possibly 10,000 years old. Obviously there were seeps or very small springs (2) from caliche which fed the playa lake in former times. Dark gray soils indicate that a swampy area once existed north of the lake. Now there is only mesquite, creosote bush, and catclaw amid many oil wells.

In southern Crane County is a large salt lake called Juan Cordona Lake. Originally it was *Cordoba* but has been corrupted to *Cordona*. In 1684 the Mendoza-Lopez expedition met Apaches with horses here. The Indians managed to steal some of the expedition's horses. Many early Americans, and also the Spaniards later, came here to harvest salt.

Seeps of very saline water (see table of Selected Chemical Analyses) still issue from Tahoka sand on the west side of Cordona Lake (11). Originally Cordona seeps were much more copious and probably fresh enough to drink. I. C. Earp, who leases this land, states that shallow wells around the lake formerly yielded good water for stock, but now it is all too saline. Many oil wells are present in and around the lake. On December 6, 1978, the lake was 80 percent covered with



Seeps at Juan Cordona Lake.

water. A few shore birds and ducks could be seen.

On the Pecos River in a reach from 14 to 30 airline kilometers east of the Ward County line a number of springs from terrace sand and gravel (7-10) feed the river. One of them, near Horsehead Crossing, was the relatively large **Antelope Spring**. Lt. Col. W. R. Shafter depicted Antelope Spring on his 1877 *Map of parts of Texas, Mexico, and New Mexico*. These springs have declined so that they are all now beneath the normal surface of the river at an elevation of around 715 meters and cannot be seen. According to I. C. Earp, their location is revealed by fish which congregate at the springs. Formerly there were springs above the river surface. Many living sites of an ancient people have been found near them.

On May 11-12, 1965, a low-flow study was made in this reach of the Pecos River by the Texas Water Development Board. The discharge was found to almost double, from 163 to 317 liters per second, in the reach, indicating an inflow from springs and seepage of 154 lps. The dissolved solids content decreased only slightly in this distance, from 19,300 to 19,200 milligrams per liter. (See table of Selected Chemical Analyses). This discloses that the chemical content of the spring water is about the same as that of the river water (very saline).

In earlier times, before the water was contaminated by man's activities, it was probably much less saline. **Wild Cherry Water Holes**, shown on a Texas and Pacific Railroad map of 1881, were evidently nearby seep-fed holes in the former river channel on the north side. They apparently held usable water at that time. The river is fringed with much salt cedar and mesquite. A few ducks stop here.

Just west of the intersection of Highways 329 and 1053 is a caliche pit (5) on K. P. Looney's property. The slightly saline water in the pit, fringed with salt cedars, stands about three meters below the surrounding ground surface. An Indian site has been found nearby. The Quaternary caliche which bears the water contains much opal. Many worked opal flakes indicate that this material was once used to make projectile points and tools.

Natural Wells (6) are six kilometers west-northwest of the same intersection, on Mrs. Al Long's ranch, leased by Gulf Oil Corporation. Jack Ellison of Crane guided the writer to these very interesting phenomena. They consist of several vertical-sided sinkholes in gypsite in an old lake bed. The slightly saline water usually stands about three meters below the surrounding surface. The wells are filled with salt cedars in which hawks and other wildlife live. Many Indian artifacts have been found nearby. Natural Wells were portrayed on Rand McNally's 1893 *Railroad and county map of Texas*.

CROCKETT COUNTY

The springs of Crockett County flow chiefly from lower Cretaceous limestones and sandstones, primarily the cavernous and vugular Edwards and associated limestones. All of these formations dip toward the southeast at about two meters per kilometer. Some faulting of the rocks is present in the northwest part of the county.

Native Americans made good use of the springs. As long as 15,000 years ago the hunting and gathering Paleo-Indians camped here. Later the Archaic Basket Makers lived near springs while raising corn, tobacco, squash, and other crops. At the dawn of history in the area the Lipan Apaches and Jumanos occupied the area. Along the bluffs of the Pecos River in northwest Crockett County there is much evidence of ancient living sites, in the form of bedrock mortars, hearths, and pictographs. Apparently the river water was much less saline then than now, and was used for drinking by these people.

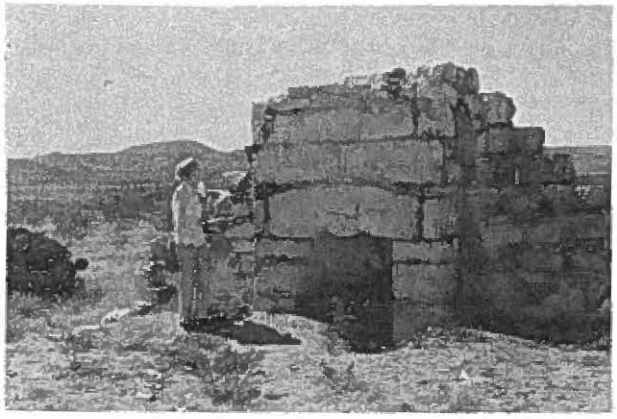
Well pumping has caused a decline in the water table which has caused many springs to stop flowing. Other factors have also been at work. The failure of many springs around the turn of the twentieth century was probably caused partly by overgrazing and destruction of the thick vegetative mat which formerly promoted recharge of water into the underground reservoirs. In the very wet year of 1974 there was a temporary rejuvenation of the springs, but the general trend has been toward drying up.

The springs are the sites of a complex biosphere. Water cress, water lilies, cattails, and maidenhair ferns are shaded by willow and other trees. Fish, crawfish, turtles, snakes, waterfowl, and the larger animals which prey upon them thrive in the springs' environment. As they dry up, many of these plants and animals also disappear.

The spring waters are generally of a calcium bicarbonate type, fresh, very hard, and alkaline. The content of fluoride and silica is usually high. Contamination of the groundwater by sodium chloride has occurred in the oil fields.

Most of the writer's field studies were made during the period December 7-13, 1978.

Live Oak Springs (2) are the source of Live Oak Creek 15 kilometers northeast of Sheffield and just north of Interstate 10. On Walter W. Owens' ranch, they issue from Edwards and associated limestones at



Ruins at Fort Lancaster.

an elevation of 660 meters. This was a popular spot for early Americans at least for the last 5,000 years. In former times the springs issued farther upstream. A large area of dark gray soils disclose that a swamp once existed here. Four kilometers northwest is a living site containing mortars and shaft-straightening grooves in the bedrock.

In 1808 Capt. Francisco Amangual camped at the mouth of Live Oak Creek on his expedition from San Elizeario to San Antonio. He called the creek *Las Uvas* (The Grapes) Creek, and found "much fresh water flowing from it into the Pecos River." In 1849 Capt. W. H. Whiting and Lt. W. F. Smith and their company stopped at Live Oak Springs. From 1855 to 1861 the water was used by Fort Lancaster, nine kilometers downstream. Later a grist mill utilized the water, according to Owens. The waters were also used at one time to irrigate crops.

On July 4, 1917, the flow of Live Oak and other springs passing Highway 290 was 142 liters per second. On December 8, 1978, the discharge at this point was 76 lps. The main springs were pouring 8.4 lps from the base of a limestone bluff into a pond on the latter date. Other springs above the county road crossing were producing 7.2 lps.

As shown in the table of Selected Chemical Analyses, the water of Live Oak Springs became contaminated, probably by oil-field activities upstream. In 1962 the dissolved-solids content reached 5,350 milligrams per liter. By 1970 the dissolved solids had declined again to 530 milligrams per liter, probably similar to the original content. A characteristic of the Edwards limestone aquifer is that it can flush out its cavities quickly when fresh water becomes available. This is not true for sand aquifers which, once contaminated, may remain so for hundreds of years.

The pond below the springs contains much marsh purslane and many minnows. Ducks, herons, killdeers, and deer frequent the site. A live oak mott is present near the mouth of Live Oak Creek. These trees are scarce here, as this is the western edge of their range. A fish hatchery now uses the spring water.

Colored Hills Springs (1) were 13 kilometers south-southeast of McCamey. Here the Mendoza-Lopez expedition arrived in 1684. Bolton (1908) describes the scene, as translated from Mendoza's account:

> I pitched the camp on a hill, according to the usage of war, separated from the said rancheria, which is at the foot of a great rock that serves it as protection against the hostile Apaches. It was given the name San Ygnacio de Loyola. Here I remained awaiting news of a great ambuscade which the enemy are coming to make on them in order to carry off many horses.

The "rancheria" or village was that of the Jediondos (Jumanos) Indians. The "great rock" was probably an isolated hill of faulted Antlers sandstone which stands three kilometers east of Highway 1901 and north of the Pecos River. The "enemy" was probably the Lipan Apaches. They did come while the Spaniards waited and made off with many horses.

On each side of the hill is a draw which probably contained very small springs in Mendoza's days. Several small shelters and bedrock mortars exist in the sandstone on the north side of the hill. Numerous artifacts and middens have been found here. Evidently the "rancheria" was quite large. Now the area is covered with creosote bush and mesquite trees, in which javelinas roam.

Six kilometers south-southwest of Barnhart on E. Linthicum's ranch is a lake surrounded by large slabs of Buda limestone. In the limestone are several dozen mortar holes, some very shallow but many penetrating through the 0.3-meter-thick slabs. Shaft-straightening grooves in the rock are also present, as well as many water-worn potholes. Many more recent names and dates have also been carved in the rock. Evidently the lake was formerly kept brimful by very small springs and seeps (13) around its shore. Several nearby wells have now lowered the water table. On December 13, 1978, there was still a small amount of water in the lake, containing much marsh purslane and water milfoil. Many ducks stop here.

The **0-9 Well** is a sort of natural well (6), fourteen kilometers southeast of Barnhart on University of Texas land leased by Kip Finley and Aubrey De Long. In the late nineteenth century it was a stop on the stagecoach

run from Ozona to San Angelo. The 0-9 ranch headquarters were established here. In 1910 geologist J. A. Udden described it as:

> a crevice known to be 140 feet deep, in which running water can be heard from the surface and from which it is at the present time pumped from a depth of 80 feet below the surface.

On December 10, 1978, the writer could hear no sound of running water at the windmill site above the cave. Finley has never heard it either. The water table has been drawn down by pumping so that the water can no longer be heard at the surface. On December 11, 1965, a group of cave explorers found water at 96 meters (314 feet) below the surface. Living in the cave or natural well and dependent upon its water are cave spiders, springtails, water bugs, and eyeless depigmented centipedes.

Udden also reported a second crevice with running water 2.4 kilometers west-northwest of the 0-9 Well. This crevice has not been rediscovered and may have been sealed to prevent loss of livestock.

Twenty kilometers east-northeast of Ozona at the P. L. Childress ranch on Turkey Roost Draw are several bedrock mortar holes. These are a sure sign that there once was permanent water in the draw. The very small springs or seeps (7) issued from Washita limestone. Now the draw is quite dry. A windmill pumps nearby.

Some residents believe that Taylor Box Springs of Taylor Box Draw were in southeastern Crockett County. More likely they were in Sutton County, just across the line.

In southeastern Crockett County was **Indian Water Hole (12)**. It was on Jess Marley's ranch at latitude 30°20' and longitude 101°10'. This was an Indian campground in past times. At that time seeps from an adjacent bluff of Georgetown limestone fed a low place in the channel of a draw. The seeps are now dry, the channel has been dammed, and a windmill pumps water into the pond. Cedar, hackberry, and mesquite trees, loaded with mistletoe, surround the site.

Seven kilometers farther west was **Big Indian Water Hole (8)** on Earl Acton's ranch. Located at the mouth of Big Indian Canyon, it also was a low spot in the channel of limestone cobbles. Formerly fed by seeps (8) from Georgetown limestone, it is now dry. Several windmills pump nearby.

On Johnsons Run at latitude 30°25' and longitude 101°12' was **Soldiers** or **Government Water Hole (10)**. It was shown on some old maps as *Lagunas* or Lakes. Here, on Eugene Miller's ranch, are several scoured-out areas in the channel of Johnsons Run which were dammed by fans of gravel washed in from side tributaries. The holes formerly contained live water. J. B. Miller (Eugene's brother) states that the Government Water Hole would "swim a horse" the year around in the 1940s. Now it holds water only for a short time after rains. Some residents apply the name Government Water Hole to a hole 11 kilometers northwest on the V. I. Pierce ranch.

On Bob Childress' ranch about eight kilometers northwest of Gene Miller's Government Water Hole were two other water holes (9 and 11). They contained live water which seeped from Georgetown limestone. There is much evidence that Indians lived here. No. 11, two kilometers west of No. 9, was scraped out once but still dried up. Near No. 9 are some old rock stock pens. The pools still collect water briefly after rains.

Howard Springs (5) are in the channel of Howard Draw on J. S. Pierce's ranch at latitude 30°28' and longitude 101°28'. They were a favorite living site of Indians, which explains why the Indians fiercely resisted being forced out of this area. In 1849 Robert Eccleston, on his way to California, described the water as "impregnated with vegetative matter and hardly fit to drink." This must have been during a very dry period. In the same year S. G. French wrote (in U. S. Senate, 1950):

> The nearest water after leaving the San Pedro [Devils River] is found at Howard's springs, forty-one and a quarter miles distant. The road is good, and the grass in the valleys very fine, consisting of gramma and fine mezquite. The springs, from the large basin they form, afford a small stream of running water in the summer, which, after flowing a short distance, sinks into the ground. Wood, in sufficient quantities for fuel, is found near the springs. It is a place much resorted to by the Indians. From thence to Live Oak creek, the next reliable water, is a journey of thirty-two miles, though after rains water may be found in pools in the rocky bottoms of ravines near the road.

In 1855 Albert J. Myer wrote:

> we had been *thirteen hours* in the saddle when we reached Howard springs. I was so tired. This was formerly one of the most dangerous spots on the road & we had some fear that we might encounter Indians as we approached it. There were none however and after a hasty glance at the pond which is called a spring and a curious inspection of a great Indian war trail — they have travelled so much over this spot that they have worn a track like a wood road — I made preparations to go to bed.

It still was very dangerous, as it turned out later. In

1858 Lt. Edward Beale, in charge of a camel train which stopped here, wrote:

> Howard's Spring is a small hole containing, apparently, about a quarter of a barrel of water, but in reality inexhaustible. It is directly under a bluff of rock in the bed of a dry creek, and to get at the water it is necessary to descend about eight feet by rude steps cut in the rock; the water has to be passed up in buckets, and the animals (21 camels) watered from them. There is but little grass here, and no timber but greasewood and mesquite, and not much of that; a few stunted cedars that grow around the bluff of the spring are neither large enough for shade or fuel.

J. C. Reid, also in 1858, found blood stains on the rocks near the springs where travelers had been killed by Indians. In 1872 the Indians struck in earnest. Chief White Horse and a band of Kiowas captured and destroyed a wagon train, killing 18 people, at Howard Springs. Lt. Col. W. R. Shafter's 1877 *Map of parts of Texas, Mexico, and New Mexico* showed the springs. Rand McNally's 1883 map, *Texas and Indian Territory*, also depicted Howard Springs. In 1879 Burr Duval (see Woolford, 1962) wrote:

> Wednesday, Jan. 14. Left camp at 7 A. M. and a 20 mile drive brought us to "Howard's Springs" or "Wells." It is in the bottom of a rocky canyon, several hundred yards from the road, dug down about fifteen feet vertically at one end, approached by a narrow flight of rude stone steps, covered with sand and gravel. The water lies in a little irregular rock basin and the supply at the time I saw it did not apparently exceed five gallons. But it appears to run in as fast as it is dipped out. The Indians for many years fought desperately for the possession of this spring, it being the only [one] in many miles around, and quite a number of graves nearby mark the last resting place of their victims. This Spring is on the great wagon thoroughfare from Chihuahua via El Paso to San Antonio, and trains of wagons are passing nearly every week and have been, perhaps, for a hundred years. During all that time this was debatable ground between the savage and the teamsters, and here occurred many sanguinary encounters.

In 1886 geologist G. G. Shumard described Howard Springs as

> a small stream of clear water, formed by the union of a number of springs which gush from beneath the limestone. The water is highly calcareous, and its temperature 71° F.

According to Mr. Pierce, in the 1890s a steam engine pumped water from the walled-up springs for cattle. Later the springs were filled with gravel by a flood. Seeps still emerge beneath the surface of a 200-meter-long pond in Howard Draw. The springs have often been called Howard's Well in recent years. The slightly saline water may have been contaminated by oil-field activities. Many trucks haul the water for oil-well drilling. The pool contains much milfoil and cattails and is fringed with baccharis and willows. Minnows gather at the fresher water near the head of the pond. Kingfishers, ducks, herons, killdeers, and deer frequent the site.

Hoover or **Panther Springs (3)** are in Spring Canyon on the east side of the Pecos River about 19 kilometers south of Fort Lancaster. On Armond Hoover, Jr.'s ranch, they issue from a cavern along a joint in Edwards limestone. Many mortar holes can be found in the rock farther up the canyon, suggesting that the springs once flowed at a higher elevation. In 1882 W. P. Hoover, en route to Fort Davis, encountered high water in the Pecos River. His wagon overturned and he lost his rifle in the river. As a consequence he decided to stop here, becoming the first permanent settler in the county.

On December 9, 1978, the discharge of fresh water was 0.22 lps. Icicles and maidenhair ferns draped the adjacent rocks. A small dam impounds the water, forming a pool in which frogs live. From here it is piped to a stock-watering trough and garden. Live oak, cedar, and pecan trees and algerita shrubs shade the site.

Escondido Water Hole (4) is 10 kilometers east-southeast of Fort Lancaster on Paul Perner's ranch. This was a popular campsite in prehistoric times. About 10 mortar holes are present in the bedrock. Rock shelters and burned-rock middens may also be seen. The Old Spanish Trail passed this spot. Three graves are located nearby. This is probably the place called **Lost Pond** by freighter August Santleben in 1873. One of his men accidentally shot himself and was buried here. In the late 1800s many names and dates were added to the Fredericksburg limestone cliffs.

Fresh water seepage normally keeps full a rock basin 30 by 15 meters in size and up to 3 meters deep. Boys swim here among the catfish and frogs. Animals such as raccoons, bobcats, and coyotes frequent the water hole. (See Plate 10, a).

CROSBY COUNTY

Crosby County was in former times abundantly endowed with springs and their accompanying wild-life systems. Most of them were located in the canyons and breaks below the caprock, and flowed from the Ogallala sand and underlying Triassic Dockum sandstone. At nearly all of them evidence of prehistoric human occupation has been found. Wayne Parker, an archeologist at Caprock, has collected a large numbe

of artifacts, many of them from the Paleolithic period, as much as 15,000 years old. In 1887 rancher Robert Tilford wrote:

> Upon my trip up White River from the House to Buck Allen's, I counted over 100 springs that are flowing and on my trip south I ceased to count after I had gone over 123.

But in the last 50 years an appalling amount of destruction to these springs has taken place, due to irrigation pumping and the accompanying drop in water tables. Crawfish Creek is now dry except during storm periods, and the crawfish have disappeared.

The county's spring waters are usually of a sodium bicarbonate type, fresh, very hard, and alkaline. The fluoride content is usually high. Most of the writer's field studies were made during the period April 5-10, 1977.

Rock House Springs (3) are near the ruins of the rock house built in 1877 by Henry Smith. The site is now leased by Anthony Latta. The house is close to the junction of Highways 651 and 193 in northern Crosby County. Smith built the house for some land speculators and took the house as compensation when their venture failed. As Lowrie (1958) states, Smith wrote in 1878

> Our party arrived here from Fort Griffin, November 1st, in good health and good spirits. Mount Blanco is situated in Canyon Blanco, and a most beautiful place it is, being the Yosemite of Texas. The Canyon is about thirty miles long and finely watered by numerous lakes of pure fresh water; and one cannot travel a half-mile without seeing a good spring.
>
> One of the best water powers in the state is at Silver Falls, at the mouth of the canyon, they fall about twenty feet. Good sand rock and coal beds are plenty. We are located near the center of the main canyon, at the mouth of Crawfish Canyon which is three or four miles wide, a fine stream of living water passes through it, being the head water of the Salt Fork of the Brazos River.

The bones of extinct mammoths, horses, and turtles have been found nearby in the canyon walls. One spring, about 100 meters northwest of the house, flowed until about 1955 but is dry now. Another, larger spring 300 meters east of the house, still flows weakly. The combined flow was 14 lps in 1938 and 0.62 in 1975.

Ericson Springs (11) are two kilometers west-southwest of Mount Blanco, on the ranch of Mrs. Georgia Ericson, granddaugher of Henry Smith. Indian burials and artifacts found nearby indicate that the springs have been used for many years. They issue from Ogallala sand in a ravine with vertical caliche cliffs. They are reported normally to run about 75 meters down the ravine, but on September 25, 1978, after much dry weather, there was only a seep. The remains of an old abandoned windmill lie in the head of the canyon. Cattails, rushes, and goldenrods adorn the site, and a pair of owls fly among the hackberry and chinaberry trees.

Dewey Springs (4) were a group of springs on the north side of old Dewey Lake, seven kilometers east-northeast of Crosbyton. The lake was formed by a beaver dam. It was cut away and the lake drained by streambank erosion in the 1880s. General Mackenzie is said to have camped here in 1872 and 1874, and in 1879-82 the Ranger Camp Roberts was located here. The springs discharged 1.5 lps in 1938. They are now dry. Historical markers are located one kilometer southwest on Highway 82.

Silver Falls, just below the Highway 82 crossing of the White River, were once a beautiful sight, with a large volume of crystal-clear spring water passing over the sandstone ledges. This was a favorite haunt of early Americans in prehistoric times, as indicated by the mortar holes still visible in the sandstone where mesquite beans and acorns were ground. Many more recent names and dates have been carved into the rock. Rushes fringe the creek, shaded by cottonwood trees. This water supplied Gen. Ranald Mackenzie's supply camp 14 kilometers downstream during the 1872 and 1874 campaigns. Since the base flow furnished by springs is disappearing, the falls are now usually dry during the irrigation season (See Plate 3, e). U. S. Geological Survey records from the stream-gauging station on the White River below Silver Falls confirm that the flow is steadily declining. This raises the question: Will the downstream White River Reservoir be able to function adequately as a source of water for the cities in the area if it must rely only on storm runoff without the spring flow?

Couch or **English Springs (2)** were 13 kilometers east of Crosbyton in Blanco Canyon, at latitude 33°39' and longitude 101°06', on the Otis English ranch. Although they flowed 54 liters per second on November 2, 1938, they are quite dry now. Some of Mackenzie's men reportedly camped here also during their campaign against the Comanches in 1874.

Davidson Springs (5), eight kilometers southeast of Crosbyton on Stanton Brunson's lease, are now dry. On November 9, 1938 they produced 2.8 lps of fresh water.

Collett or **Cold Springs (9)**, are on the L7 ranch, 13 kilometers southeast of Crosbyton, operated by Kenneth Leatherwood. They issue from sandstone in a bluff on the west side of the White River. They

flowed 2.1 lps of fresh water in 1938 and 1.6 in 1977. The water is collected in a reservoir and used to irrigate a pecan orchard. Willows and cottonwoods surround the site, and ducks like to stop here. Many artifacts found in the vicinity indicate that the site was long used by an ancient people.

At the headquarters of the L7 ranch, 15 kilometers south-southeast of Crosbyton, are **L7 Springs (6)**. In 1938 they produced 3.5 liters per second of fresh water from Dockum sandstone. By 1977 the flow was reduced to 0.05 lps. The old springhouse, which was used to keep milk cold when the ranch was established in 1880, still stands in a grove of trees. Maidenhair ferns grow below the springs. Near the Morgan Jones Comanche burial site three kilometers north, another group of very small springs still flowed 0.06 lps on April 6, 1977.

Wilson Springs (10) are four kilometers east-southeast of Cap Rock on Delton Caddell's ranch. In the 1940s they were a favorite haunt of John Wilson of Tulia, who lived nearby. They issue from Ogallala sand containing many calcium carbonate nodules. The ravine has been deepened as much as five meters by severe valley trenching. On September 10, 1978, after much dry weather, 0.55 lps trickled from numerous seeps. Many frogs and birds live here, shaded by a few cottonwoods and many cedar trees.

Abandoned spring house at L7 Springs.

Cottonwood Springs (1) are 16 kilometers east-northeast of Slaton on Plum Creek. Part of General R. S. Mackenzie's force camped here while chasing Comanches in 1874. While here, a severe norther struck, killing many of their horses. Although located in rough uninhabited country, the springs can be reached easily on good oil-field roads. Marked by large cottonwood trees, they flowed 13 liters per second in 1938 and 0.32 lps in 1975.

Fourteen kilometers east-southeast of Slaton, on Clark Wood's C Bar ranch, are the **C Bar Springs (7)**. They formerly supported an Indian camp. In 1938 they poured out 19 lps of fresh water from Dockum sandstone. In 1977 the seepage was barely sufficient (0.50 lps) to counteract evapotranspiration in the downstream Spring Lake. Cottonwoods surround the site which is frequented by ducks.

Gholson Springs (8) are 10 kilometers east-northeast of Slaton, in a small canyon on the north side of the Double Mountain Fork of the Brazos River. According to Holden and others (1972), a well-worn Indian trail passed these medium-sized springs in prehistoric times. In 1541 part of Coronado's Army may have camped here. By 1977 only 0.03 lps was flowing from the sandstone.

CULBERSON COUNTY

For at least the last 12,000 years, and probably much longer, man has made his home near the springs of Culberson County. The springs in the Guadalupe Mountains have yielded an especially rich assortment of artifacts and middens of various ages. Similarly the springs around Van Horn have furnished many Folsom, Plainview, and other projectile points, gravers, and scrapers. Together with these artifacts have been found the bones of extinct bison, dire wolf, and musk ox which were hunted by these ancient people.

In the late 1500s Spanish conquistadors passed through the present county on their journeys north from New Spain and found the Mescalero Apaches living at the springs. Later Texas and U. S. troops, wagon trains, and stagecoaches found the springs extremely important, because in this generally dry country sources of good water are few and far between.

Most of the writer's field studies were made during the period April 22-30, 1976. There are three principal areas in which springs occur in Culberson County: the

Guadalupe Mountains in the northwest, the Rustler Hills in the east, and the Apache, Van Horn, and Diablo Mountains in the southwest.

Guadalupe Mountains

In and near the Guadalupe Mountains very small to medium springs discharge chiefly from Permian sandstones and gravel fans or *bajadas* at the foot of the mountains. Here a rare mixture of biotic communities is dependent upon the spring waters. Ferns, big-tooth maple, chokecherry, walnut, hophornbeam, and the Texas madrone tree with its flesh-colored trunk are common. Animals frequenting these springs include trout, elk, mule deer, wild turkey, ringtail, and occasionally black bear and cougar. Many animals such as the grizzly bear and bighorn sheep, described here by Marcy in 1851, have long since been killed off. The National Park Service at Guadalupe Mountains National Park is studying these rare plant and animal species. It is hoped that they can be saved or restored, provided that the springs can be preserved.

At the end of glacial time, about 10,000 years ago, the Salt Lakes were full, standing about 12 meters above their low point. In the 1920s there was still some water usually in the lakes. But now irrigation pumping has so lowered the water table that the Salt Flats are dry and increasingly used as a racetrack for recreational vehicles.

Before 1905 there were no valley trenches in the upper stream reaches — only wet swales covered with high grasses. Overgrazing destroyed the grasses, which had only a fragile hold on the soil, and gullying began. This contributed to lowering of the water table and buried downstream springs under sediment.

Many springs in the Guadalupe Mountains area have failed, chiefly because of well pumping, but also because of overgrazing which destroyed the lush vegetation and organic mulch, greatly reducing the soils' capacity for recharge. Earthquakes and floods have contributed to the damage to the groundwater reservoir.

The water is generally of a calcium bicarbonate type and is fresh, alkaline, and very hard. The greatest spring flow is usually in the spring months, being derived from snowmelt. Some of the highest springs in Texas are located in these mountains.

Six kilometers west-southwest of the Pine Springs store and one east or up the canyon from the old Williams ranch headquarters, is **Bone Spring (4)**. R. D. Read, on his 1879 *Map of field operations of Company K, 10th Cavalry*, called it **Bowen Spring**. Originating from Brushy Canyon sandstone which dips steeply to the south, the spring has produced from 0.10 to 0.30 lps in recent years. A Comanche campground was once located here, and in 1880, reluctant to give up this choice living site, the Indians fought an Army group at the springs.

Bone Spring's flow disappears in gravel about 100 meters downstream. The remains of pipes which carried the water to the ranch headquarters may still be seen. Only four-wheel-drive vehicles are permitted to visit this area. The spring has an interesting community of wildlife which is dependent upon it for existence, and which is being studied by the Park scientists. A cottonwood tree shades caves where owls lurk in wait for prey. A red-tailed hawk screams while canyon wrens flit among the trees. **Howell** and **Goat Seeps**, shown on some old maps, are on the west slope of the Guadalupes about five kilometers northwest and three kilometers north of Bone Spring respectively.

Guadalupe Spring (11), three kilometers east-southeast of Bone Spring, was well described by Marcy in 1851:

> . . . we reached a rocky ravine which led us directly up to the foot of the towering cliff of the peak. We encamped near the head of the ravine, where there is a spring about 200 yards north of the road, and good grass. Animals must be driven up the ravine to the water, as the wagons cannot pass further than the turn of the road.

Pine Springs (1) were located ½ kilometer northwest of the settlement of that name. Middens, projectile points, and potsherds indicate that they were extensively used by prehistoric people. In 1849 Bryan described them as follows:

> Marched today 6 miles to a fine spring of pure cold water, at the foot of Guadalupe, and encamped. The spring is about ¼ of a mile to the right of the road, in a corner of the mountains. Here we found excellent grass for the animals, good water, and fine large timber of pine, cedar . . .

Marcy (1851) said,

> As it rained most of the afternoon, we only made a short march of four miles, passing in a northeast direction around under the mountains, and encamped in a ravine which runs down through a large grove of pine timber from a gap of the Guadalupe mountains; there is a fine spring three hundred yards to the west of the road, which affords an abundant supply of water.

Marcy called these springs **Ojo del Camino (Road Spring)**. In 1858 and 1859 Pine Springs or "The Pinery" station was a regular stop for changing teams on the four-horse, Concord stagecoaches. Later the Butterfield Overland mail line was shifted to the more southerly Davis Mountains route. In 1878 and 1879 soldiers from nearby military posts occasionally camped here while trying to catch up with the remaining Apaches. The springs are reported to have failed during the west Texas earthquake of August 16, 1931. Probably there was some movement in the fault in Cherry Canyon sandstone from which the water flowed, blocking further discharge. The ruins of the old stage stand and a historical marker may be seen just north of Highway 62 at Pine Springs.

Upper Pine Springs (2) are two kilometers north of the Pine Springs settlement at an elevation of 1,860 meters. These fresh-water springs issue from the Cherry Canyon sandstone. The flow of 0.20 to 0.50 liter per second in recent years disappears 50 meters downstream into cobbles and gravel. Large pine trees still exist here. The springs can only be reached by walking from the highway.

Three kilometers north-northeast of Pine Springs are **Smith Springs (3)**. They were depicted as Indian Springs on Jacob Kuechler's 1879 *Map of the Texas and Pacific Railway reserve west of the Pecos*. Among the highest springs in Texas, they issue from Bell Canyon sandstone at 1,815 meters above sea level. The rocks are covered with maidenhair ferns, and a big-tooth maple tree stands over the springs. Discharge measurements, in lps by water years, are:

1968	1.9	1973	2.5
1969	2.3	1974	2.3
1970	2.5	1975	2.5
1971	2.3	1976	1.7
1972	2.3		

Juniper Spring is a very small spring one kilometer east of Smith Springs. There are also a number of small springs (10) in McKittrick Canyon, in Texas and New Mexico, 8 kilometers northeast. The creek here was reported to be flowing 21 lps in places in December, 1968. There are numerous legends of gold mines and buried gold in this area. **McKittrick Springs** support a wide variety of plant life, including ponderosa pine, douglas fir, big-tooth maple, and a species of columbine found nowhere else in the world.

Manzanita (Little Apple) Springs (9) are three kilometers northeast of Pine Springs and ½ kilometer east of the old *Frijole* (Bean) post office. Originally there was a bog surrounding them. For this reason they were shown on maps of the 1870s and 1880s as **Cienaga (Bog), Tule (Rush)**, or **Escondido (Hidden) Springs**. Since 1968 they have discharged 0.60 to 1.9 lps of fresh water. Emerging from a gravel and cobble *bajada* on top of limestone, they have built up a deposit of travertine. They discharge into a small pond surrounded by trees. Included are some madrone trees whose trunks are pink until they peel in the summer. The edible fruits are called little apples or *manzanitas*, which give the springs their name. Manzanita Springs are supplied by water from Smith Springs which reappears from the gravel here. One kilometer southwest is the very small **Frijole Spring** which formerly supplied water to the Frijole ranch headquarters.

Choza (Hut) Springs (5) were 2.5 kilometers northeast of Pine Springs. They flowed 1.9 to 2.8 lps in 1968 and 1969 from Cherry Canyon sandstone, but were dry in 1976. A stock tank has been built here, and water is piped from the upstream Manzanita Springs in an effort to fill it.

Outside of the National Park, but still in the Guadalupe Mountains area, are several important springs. **Soldier Springs (6)** are six kilometers northeast of Pine Springs and just south of Highway 62, at elevation 1,555 meters. They flow 0.75 lps of fresh water from Cherry Canyon sandstone. A grove of hackberry and other trees surrounds the springs. As a well has been installed here and others are nearby, these springs are probably not long for this world. **Nickel Springs** are nearby, and three kilometers north is the very small **Bell Spring**.

Independence Springs (7) are nine kilometers east of Pine Springs and two southwest of the D ranch headquarters, at elevation 1,440 meters. They flowed 1.0 lps in 1976 from Cherry Canyon sandstone. A Comanche campground was once located here. Bryan (1849) wrote:

> Arrived at 1 o'clock at Independence Spring, the water of which is very fine, being pure and cold. Here we found the first trees we have seen since we left the Concho.

Marcy (1851) was also favorably impressed:

> . .. we moved forward over a good road to Independence Spring, five miles. Here we found two large springs of pure cold water, which boil up from the ground and run off in a stream about the size of a barrel, with a great supply of oak wood and grama grass near, rendering it a most desirable place for encamping.

In 1854 Capt. John Pope wrote:

> . . . Independence Springs, which burst from the surface of the ground in a small valley or depression in the table-lands. They are two in number, and uniting at a short distance below, they flow off to the southeast in a small stream, which, within a few miles, becomes dry. . . . These springs are five feet in diameter; and although a pole ten feet long was thrust into them, the bottom was not reached.

In the 1850s a stage stand on the Butterfield Overland mail route was established here. A small graveyard is located near the springs. A grove of trees surrounds them. The flow is piped to other parts of the 145-section (375-square-kilometer) ranch for stock use. At the D ranch headquarters is a smaller spring surrounded by cottonwood trees. Flowing 0.35 lps in 1976, it supplies the headquarters buildings. About eight kilometers northeast of the headquarters were **Rector Springs**, which have now dried up.

Delaware Springs (8) are some 33 kilometers east of Pine Springs, just south of the 9K ranch headquarters, at latitude 31°52' and longitude 104°29'. Also called **Head Springs**, **Five Springs**, and **Ojo de San Martin** at various times, they are the source of Delaware Creek. Capt. Francisco Amangual camped here in 1808 on his journey from San Antonio. He called the place **La Cienaga (The Swamp)**. In his words,

> There were many pools of water here. The pool on the west contained much sulfur and copperas. The pools to the east contained less and less.

In 1849 Bryan stated,

> Our camp is in a small valley, where there are three fine springs; one is highly impregnated with sulphur, another with salts of soda, while the third is of the best and purest water, suited for the use of man and beast. Grazing at this camp is very good.

Marcy (1851) wrote:

> There are several springs at this place, the waters of which unite and form the Delaware creek. One of them, the Ojo de San Martin, bursts out of a solid limestone rock in a volume of sufficient magnitude to drive an ordinary saw-mill at the fountain head, and is as pure, sweet water as I ever drank.
>
> Above this there are several others possessing different mineral properties. One is highly charged with sulphuretted hydrogen, and tastes very much like the Kentucky "Blue Lick water." Another is decidedly chalybeate, and a third is strongly sulphurous, leaving a thick incrustation of sulphur upon the rocks for many yards from the source.
>
> These unite in one common outlet, and the amalgamation is far from pleasant to the taste.
>
> Is it not within the scope of probabilities that these springs may be found to possess valuable medicinal properties, and that this place may yet (and at no very distant period) become a place of fashionable resort for the "upper-ten-thousand" of New Mexico? The climate here is delightful, the atmosphere perfectly elastic and pure, and the temperature uniform and delicious; then, may not an invalid derive as much benefit at this place as at Saratoga or any other of our watering places?
>
> . . .
>
> We found the stream at this point literally alive with a multitude of fish, and in a very short time we caught enough to supply the whole command. Among other kinds, we caught a white bass that I have never seen anywhere before, and found it very excellent.

Pope's description in 1854 throws additional light on Delaware Springs as they appeared at that time:

> The creek itself is a succession of small lakes, ten or fifteen feet deep, connected by a swift running stream, and as it is ascended from the mouth the dwarf cedar becomes much more abundant along the ridges. It has its source in a limestone bluff about fifty feet above its valley, and issues from the base of the bluff from seven or eight springs, both pure and mineral. The largest of the pure springs bursts boldly out of the north side of the hill in a stream as large as a barrel, and after a course of probably fifty yards unite with the small streams from the mineral springs. These springs contain sulphur in various proportions — in some barely perceptible, while in others it gives out an odor which is sufficiently perceptible at fifty yards. There are six of these sulphur springs. From the south side of the bluff issues a spring strongly impregnated with soda, and all the springs uniting in one of the small lakes or ponds of Delaware Creek form a compound detestable both in smell and taste. The animals, to my surprise, greatly preferred this lake to the pure water of the spring.

Contrary to Marcy's expectations, no health resort was ever built at Delaware Springs. However, the springs have always been very popular. Jax Cowden, owner of the 9K ranch, has a collection of projectile points including some large-stemmed Paleo-Indian points which were found near the springs. Evidently the springs have been highly valued for many thousands of years. In 1870 a regiment of the Ninth Cavalry fought a band of Indians camping here, killing one.

Delaware Springs discharge from gravel deposits on top of the Bell Canyon limestone, which is faulted at this location. In 1976 the main springs flowed 14 lps of fresh water containing about 1,000 milligrams of dissolved

Delaware Springs.

solids per liter, making them the largest fresh-water springs in the county. The smaller, mineralized springs produced about 1.7 lps, with much hydrogen sulfide (rotten egg) gas and a black mineral deposit on the rocks. The stage stand which was here in the 1850s is now gone. There are large pools with much water cress, and some good-sized fish.

Rustler Hills

In the Rustler Hills of eastern Culberson County, which are often completely bald of vegetation because of the high gypsum content of the soils, a number of medium-size springs flow from cavernous Permian gypsum. Here the roads often consist of gypsum powder 0.3 meter deep which raise enormous, thick dust clouds when traveled by automobile. The water is high in gypsum (calcium sulfate), and is usually slightly to moderately saline, very hard, and alkaline. The greatest rainfall, and spring flow, occurs in the period of July through September.

Willow Springs (14) are 24 kilometers southeast of the State Line Cafe at the junction of Highways 62 and 1108, on the south side of Delaware Creek, at latitude 31°54' and longitude 104°18'. A reported 13 lps flow from cavernous Castile gypsum. A grove of hackberry trees surrounds the springs. The water is quite "gyppy" and moderately saline. **Castile Springs**, 11 kilometers south, are only seeps now.

Horseshoe Springs (21) are 13 kilometers northwest of the Duval plant on Doug Miller's ranch. In 1976 they flowed 1.7 lps from Rustler gypsum, which forms a large bare rock area around the springs. There is a grove of big salt cedar trees, and black-tailed deer drink from the springs. The water tastes fresh when cold but is noticeably mineralized after standing.

Sixteen kilometers west of Orla are **Screwbean Springs (12)**, the source of Screwbean Creek. They issue from a fault in the Rustler and Castile gypsums. In former years there were springs as far as 10 kilometers upstream from their present location. Producing 20 lps in 1976, they are the largest springs in the county, but are moderately saline. Salt cedar trees are numerous here.

Twenty-five kilometers southwest of Orla and just northeast of the Duval sulfur plant are **Virginia Springs (20)**, at latitude 31°43' and longitude 104°06'. The springs flow from cavernous Rustler and Castile gypsum, at about 7.0 lps. They supply several ponds loaded with ducks and surrounded by salt cedar. The flow has been greatly augmented by the injection of water under pressure during sulfur mining. The injected water is piped from a well field 80 kilometers south in the Davis Mountains.

A group of springs called **Maverick Springs (19)** are about three kilometers east and northeast of the Duval plant. They flow from cavernous gypsum, some beneath the surface of an alkaline lake or marsh which has a clear green color. A strong hydrogen sulfide odor surrounds them. (See Plate 13, a). Large hawks were making their home here at the time of the writer's visit. The water is moderately saline and high in calcium sulfate (gypsum) as shown in the table of Selected Chemical Analyses.

Rustler Springs (13) are at the old Rustler Springs ranch headquarters, some 37 kilometers southwest of Orla and 10 kilometers west of the Duval sulfur plant, which now owns them. They are at latitude 31°42' and longitude 104°10'. A gang of rustlers once made their headquarters here, preying on cowmen as far east as Buffalo Gap near Abilene. But the cattlemen trailed them to Rustler Springs and hanged five from a nearby cottonwood tree.

Flowing 1.0 lps from cavernous Rustler gypsum, Rustler Springs now supply a stock pond frequented by many ducks. The road south from Highway 652 to the springs is very difficult, crossing much gypsum rock and powder. Pete Wilson of the Duval Corporation kindly provided the analysis of the water which appears in the table of Selected Chemical Analyses. As may be seen, the water is slightly saline, containing much gypsum.

Farther south, on land owned by the Elcor Chemical Corporation, are **Pack Springs (22)**, at latitude 31°22' and longitude 104°22'. Just north of Spring Hill near the old Rock House ranch headquarters, they were portrayed on nineteenth century maps. The water now seeps from the Rustler gypsum into five earth tanks surrounded by salt cedar. Although cattle drink it, it is too saline for human consumption. Walking catfish are reported to have been introduced into these ponds.

Hurd Springs (25) were on the Rachal ranch in southeast Culberson County, owned by G. R. Bryan and leased by Mike Fussel. They were on Hurd's

Pasture Draw at latitude 31°15' and longitude 104°12'. They emerged through alluvial deposits from faulted lower Cretaceous limestones. There is still some wet-weather seepage here, according to Fussel.

Eight kilometers farther east at Bryan's Diamond T ranch headquarters, close to the Reeves County line, there was once a seep-fed lake (30) with a large Indian village. Burned-rock middens and many projectile points have been found here. According to Fussel, the water level is now three meters below the ground surface.

Apache, Van Horn, and Diablo Mountains

In and near the Sierra Diablo and Van Horn Mountains, and formerly in the Apache Mountains, a number of very small springs and seeps occur. They flow from a variety of rocks, including Precambrian sandstones, Tertiary volcanic rocks, and Quaternary gravels. The greatest discharge takes place in the spring as a result of snowmelt. Because of man's abuse of the land and its subsurface aquifers, most of them have ceased flowing. All of these springs were much stronger in 1881, when many were used by the railroads. Following about 25 centimeters of rainfall in September, 1978, many springs revived temporarily. Generally the water is fresh, very hard, and alkaline, being of a calcium bicarbonate type.

Thirty-two kilometers northeast of Van Horn, on the Apache ranch in the western end of the Apache Mountains, there was formerly a very small spring (27). It flowed from faulted Capitan limestone, but has long been dry.

Nineteen kilometers southwest of Kent, on Bill Cowden's EB ranch, was the **Joe Ellis Water Hole (26)**. Here Major Robert Neighbors stopped on his expedition to El Paso in 1849. Chalcedony and flint flakes scattered here indicate that the site was popular in ancient times. There were very small springs, now long dry, from Lower Cretaceous limestones in the draw here. Antelope and horned toads still roam among the hackberry trees and sotols.

Eight kilometers east-northeast of Lobo is Lawrence and Elizabeth Hoskins' ranch headquarters. Here, according to long-time resident Dick Christopher, were springs (28) which still flowed in 1938. They issued from Tertiary igneous intrusive rocks in a boulder-strewn draw. Soon after 1938 they dried up. Much blackbrush now covers the site. Similar very small springs also trickled on the Johnny Garren ranch six kilometers south-southeast in 1938, according to Christopher.

Nineteen kilometers south of Van Horn and about one west of Highway 90 are **Van Horn Wells (17)**, which were once springs. They flowed from the Neal fault on the eastern base of the Van Horn Mountains, between Tertiary volcanic tuff and pediment gravel. They were described as follows by the Conklings (1947):

> The wells are situated in a slight depression in the eastern foot hills of the Van Horn mountains. Although the main supply is now obtained by pumping and impounding the water, it is evident that there were originally permanent ponds of water here surrounded by rushes and willows. This watering place was regarded by early travelers as the most dependable on the route between the Limpia and the Rio Grande.

The fresh water of Van Horn Springs was much used by the Indians, soldiers, and wagon trains on the San Antonio to El Paso road. Traveler John Rich in 1856 described the springs as "a funnel-like hole in the ground, a few feet wide and deep, filled with water." U. S. infantry were stationed here in 1859 while fighting Indians. A Butterfield Mail stage stand was located here from 1859 to 1882. The springs have been dry for many years.

The figures shown in the table of Selected Chemical Analyses are for water from a shallow, nearby well. Agate and chalcedony specimens abound at the site. Historical markers are present at Highway 90 and at the former springs. Several small springs which formerly flowed near High Lonesome Mountain 8 kilometers to the south are also dry now.

Carrizo (Reed) Spring (16) is 10 kilometers northwest of Van Horn, on the Hudspeth County line, on the McVay ranch. Folsom projectile points found near here indicate that as long as 10,000 years ago this was a popular haunt. In 1849 Major Robert Neighbors reported a plentiful supply of water in Carrizo Pass, and probably stopped at this spring. The Apache chief Victorio and his small band stopped here en route to Mexico in 1880 after being repulsed from Rattlesnake Springs. At that time water flowed from the Carrizo Spring fault in the Van Horn conglomerate, but the spring is now dry. A windmill well at the site is undoubtedly the chief culprit in the demise of the spring.

Twelve kilometers northwest of Van Horn on the McVay ranch are **Grapevine Springs (15)**, at latitude 31°08' and longitude 104°54'. This is an extremely interesting area geologically and scenically. The springs flow from the Grapevine fault between the Van Horn and Hazel sandstones, which form numerous cliffs and shelters. These Precambrian rocks were deposited over one billion years ago, when only primitive forms of life

such as algae and bacteria existed on earth.

In 1849 William Whiting of the Corps of Engineers described Grapevine Springs (Whiting and others, 1938):

> After a very thirsty and weary march this morning, it was with great delight that we hailed the discovery by Lieutenant Smith of springs of cool and delicious water far up in a ravine, among huge rocks and overhung by large Spanish oaks.

Grapevine Springs were later very popular for picnics. They were also a favorite haunt of prehistoric men, as evidenced by numerous artifacts and bedrock mortars in the sandstone, which were used to grind corn and beans. Now, however, they are only seeps which provide some water for stock. Several other seeps may be seen along the fault, marked by small groves of trees, in an area which is largely composed of bare rock. A talc mine is located one kilometer east, where the fault passes Tumbledown Mountain. There is a good mine road to within one kilometer of the springs.

Seven kilometers north are the similar **Yellow Springs**. About six kilometers northeast of Grapevine Springs was the seep-fed **Sulphur Water Hole** on Sulphur Creek. In 1880 Company G of the 10th Cavalry stopped here after the Rattlesnake Springs massacre.

Thirty-five kilometers north of Van Horn on the Longfellow ranch is the probable site of **Rattlesnake Springs (18)**, at latitude 31°21' and longitude 104°51' near the mouth of Victorio Canyon. The springs flowed from Quaternary sand and gravel, but are now only seeps. Several nearby wells no doubt contributed to the springs' failure.

This was a popular place with prehistoric people. Near Rattlesnake Springs is a rock shelter with pictographs of men, long-tailed deer, and bighorn sheep, and several burned-rock middens. In 1880 this was the site of the last Indian "battle" in Texas, in which eight Indians of Victorio's band, including two women and two children, were slaughtered by Col. B. H. Grierson's command. The springs reportedly ran red with their blood.

Eleven rare and endangered species of plants may be found here. Ferns, fragrant ash, and bigtooth maple thrive in the canyon. Bighorn sheep are making a comeback after near extinction in the area. Golden eagles once soared over the springs, but no more.

DALLAM COUNTY

Very few springs remain in Dallam County, but at one time there were numerous and large springs, especially along Coldwater and Rito Blanco Creeks. *Rito Blanco*, meaning White Valley, is now usually spelled Rita Blanca. The springs emerge from Ogallala sand and caliche and from the underlying Dakota sandstone.

Many artifacts found at the springs testify to their long use by prehistoric people. Naturally early trails through the county touched at the springs, and the first settlers built their cabins near them. In prehistoric times the spring-fed Coldwater and Rito Blanco Creeks flowed constantly through most of their lengths. In 1929, according to R. P. Hamilton, who lives nearby, Coldwater Creek flowed all the time from Buffalo Springs to Black Muley Camp 15 kilometers downstream. In the 1950s the flow became intermittent, existing only in winter, and then shrank to a two-kilometer reach downstream from Buffalo Springs. Rito Blanco Creek has had a similar history.

The chief cause of the drying up of the springs is pumping of ground water for crop irrigation, which has accelerated at a fearful rate in recent years. There were other earlier causes, such as stock and domestic wells and flowing wells which were allowed to waste water and thus lowered the water table.

The area around the springs formerly swarmed with wildlife, including bison, antelope, deer, wild mustangs (introduced by Spanish explorers), wolves, prairie dogs, rabbits, many varieties of fish, geese, ducks, cranes, shorebirds, and coots. With the disappearance of most of the springs and the loss of their natural habitat, many of these animals can no longer survive in the area. Still, according to the U. S. Forest Service, 6 species of turtles, 9 lizards, 28 snakes (including 3 poisonous species), 4 salamanders, 5 toads, and 4 frog species may be found in the Rita Blanca National Grassland.

The spring waters are generally of a calcium bicarbonate type, fresh, very hard, and alkaline. The fluoride content may be high. The writer's field studies were made chiefly during the rainy period of May 22-27, 1977.

About two kilometers south of Texline on West Rito Blanco Creek, on the James Bleiker ranch, were some springs (1) which continued flowing intermittently until about 1965. They trickled from sand on top of a ledge of Dakota sandstone which crosses the creek here. According to R. F. Hefley of Texline, the creek (called Perico Creek in New Mexico) still is spring-fed down to a point about eight kilometers upstream. Many projectile points have been found here, and the site is still marked by a cottonwood copse.

Fifteen kilometers east of Texline on Rito Blanco Creek are **Horseshoe Bend Springs (2)**. Around

1945 there was a deep swimming hole here, which has now been filled with sediment. The creek was running deep with muddy runoff on May 24, 1977, but R. F. Hefley reports that there still is "live" or seep-fed water in the creek. Many flint artifacts found here point to use of the springs by early Americans. Water-loving grasses in places on the adjacent slopes indicate that seeps are still present. Salt cedars and willows fringe the creek.

Three kilometers farther downstream are **Kimble Springs (3)**, which were depicted on a Texas General Land Office map of 1881. They also are reported to be only seeps of live water now by Hefley, but could not be seen by the writer because of flood water. A cottonwood grove still stands here.

Springs probably also ran on Carrizo Creek in the past, although no one now living can remember them. *Carrizo* means reed, and suggests wet conditions. Most of the creeks which enter the county from New Mexico are reported by Noel Higgins and others of Texline to flow still down to a line about 15 kilometers west of the state line. This is due in part to the fact that less pumping for irrigation is practiced in New Mexico.

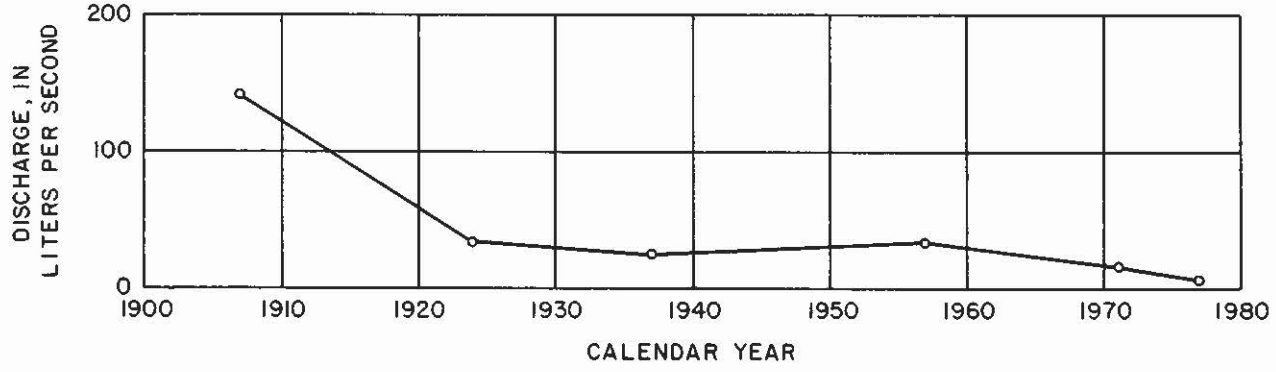
Buffalo Springs (7), the largest in the county, are near the Oklahoma state line at latitude 36°29' and longitude 102°47'. They gush from numerous openings in Dakota sandstone at an elevation of about 1,300 meters on the Shamburger ranch, operated by W. J. Bryan. They were formerly a favorite watering place for herds of buffalo, wild mustangs, and other animals. An Indian settlement was located here, as evidenced by numerous dart and arrow points and other artifacts found in the vicinity.

In 1878 cattle ranching began, and Buffalo Springs were made the site of the XIT ranch first division headquarters. There were fabulous stories of the depth of the chain of deep, dark, clear pools. Because of the steep banks, watering a herd of cattle here was difficult. In 1885 a disastrous grass fire broke out in Kansas and swept past Buffalo Springs to the Canadian River breaks. The XIT ranch alone lost nearly one million acres (405,000 hectares) of grass. Wild buffalo were last sighted in Texas at these springs around 1895. In 1907 the water was used to irrigate 60 hectares of alfalfa and garden crops. Between 1925 and 1933 more than a million ducks and geese still stopped here annually.

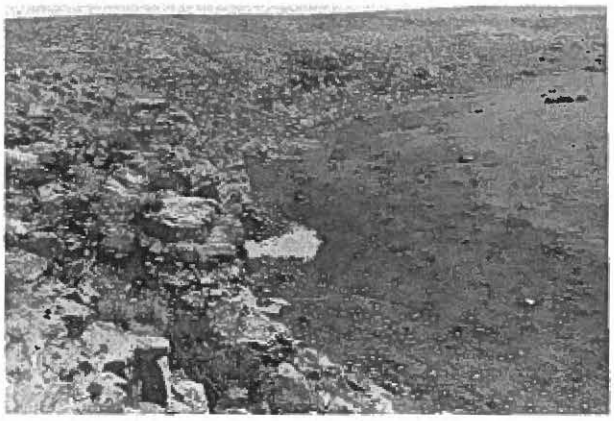
Now Buffalo Springs feed several pools containing many cattails and horsetails and shaded by cottonwoods, elms, and willows. (See Plate 15, d). Swallows, killdeers, ducks, and turtles are numerous. Dark gray organic soils signify that a large swamp once existed downstream. One kilometer east of the springs is a historical monument. Irrigation pumping to the west has greatly reduced the flow in recent years. Discharge records are shown on the accompanying graph.

Seven kilometers south of Buffalo Springs were **Flater Springs (6)**, now on Bert Wilhelm's ranch. Formerly feeding Flater Lake (now dry) the springs have dried up due to extensive irrigation pumping in the area. A shallow well still flows intermittently here.

Potato Spring (4), ten kilometers south-southeast of Buffalo Springs, is in the Rita Blanca National Grassland. It formerly fed a lake which is now dry. The water now oozes forth at a rate barely sufficient to supply a water trough, even though the spring outlet has been considerably lowered by trenching. Marsh grasses and Russian olive trees are abundant. The water was once used to irrigate potatoes.



Discharge of Buffalo Springs.



Seeps at Agua Fria.

Six kilometers southeast of Buffalo Springs are **Government Springs (5)**, also in the Rita Blanca National Grassland. They formerly supplied Ewings and Coldwater Lakes, which are now dry. About 0.03 lps seeps from Dakota sandstone containing cavities and much calcium bicarbonate in the joints. It is piped to a steel stock tank. Marsh grasses surround the springs. Several old, shallow, apparent mortars in the sandstone boulders suggest that this was a campsite of prehistoric people.

Black Muley Springs (8) were 15 kilometers southeast of Buffalo Springs at Black Muley camp on Coldwater Creek. This was where a special breed of cattle called Black Muleys or Polangus were kept by the XIT ranch. Although the springs are now dry, Burton Hanbury of Dalhart, formerly with the XIT ranch, remembers when they flowed.

Farther downstream on Coldwater Creek, three kilometers east of Highway 385 on the Hartshorn ranch, are **Agua Fria** or **Coldwater Springs (9)**. An 1881 Texas General Land Office map called them **Cave Springs**, in reference to the caves in the Dakota sandstone bluffs from which they issue. The XIT ranch Lost Camp was located here. In 1907 Gould described them as producing somewhat less than 28 lps. In April 1937 they yielded 0.63 lps, with a lesser flow in summer. Now they consist only of seepage in a wet area which extends along Coldwater Creek for about a kilometer. A few spots have been deepened to form stock pools, fringed with cattails and bulrushes.

DALLAS COUNTY

There is little doubt that prehistoric men and women frequented the springs of Dallas County 30,000 to 40,000 years ago. At Lewisville, a short distance northwest of Dallas County, some of the earliest known human artifacts in America have been dated by radiocarbon methods to be at least 38,000 years old. In 1542 the Spanish explorer Moscoso is believed to have passed through northwest Dallas County, perhaps stopping at Grapevine Springs. Other early explorers who must have camped at the springs in the county include the French traders Antoine Crozat and Bernard de La Harpe, who traded with the Anadarkos on the Trinity River in 1712 and 1719. The Anadarkos or Caddoes lived in thatched huts along the river, growing maize, beans, pumpkins, and tobacco. When the first permanent white settler, John Bryan, set up camp on a bluff at Dallas, the springs of the area had been in use for many millenia.

Water tables, especially in the Travis Peak formation, have fallen spectacularly as a result of heavy industrial and municipal well pumping. For example, in one well the pumping level declined 92 meters in a 3½-year period. As a result most of the county's springs have dried up.

The spring waters of the county are generally of good quality, being of a calcium bicarbonate type. They are usually fresh, alkaline, and very hard. Except where otherwise noted, the writer's field studies were made on December 22-27, 1975.

Some species of crustaceans live in seeps on Turtle Creek in north Dallas and nowhere else. If these seeps are allowed to dry up or become contaminated, these life forms will of course become extinct.

Browder Springs (1), in Dallas' City Park, have had a very great effect upon the city. Named for the Browder family which originally owned them, they were Dallas' principal source of water before wells were drilled. At first a water wagon distributed the water from the springs. In 1872 a water system was installed, pumping water from the springs. In 1871 the Texas Legislature passed a bill which required that the Texas and Pacific Railroad should pass within one mile of Browder Springs. This of course meant that it must pass through Dallas, although the railroad officials did not at first realize it.

During the drought of 1909-10 Browder Springs were reopened and supplied 44 liters of water per second to the city. The water flowed from a river terrace, probably originating from the Austin chalk beneath. The springs are dry now, and the vicinity has been greatly disturbed by freeway and other construction. A historical marker is present, and guided tours through pioneer houses in the park are available.

Van Benthuysen Springs (2) are named for Lieutenant Van Benthuysen, who with Lieutenant Miles commanded a group of about 50 men who en-

Kidd Springs.

countered a superior force of Indians in Wise County in 1837. Miles and eight others were killed, a number wounded, and all their horses lost. As Brown (1887) describes it,

> For five days they followed the river down its meanders till they reached the junction of the Main and Elm forks, three miles above this city. On the sixth day they crossed to the east side at the mouth of Turtle creek, and, a mile and a half below, came to the bluff, rising above overflow, where the village of Dallas was founded or first settled four years later. Some suffering with wounds, all well-nigh denuded of clothing and their flesh torn with thorns, they resolved to halt for repose. With mud and oak ooze their wounds were poulticed, buffaloes were killed for meat, their hides converted into moccasins and "leggings," and after three or four days thus spent at the spring near where Jackson street crosses the town branch, they recrossed the river and traveled south along the prairie, but always near the timber for protection, if attacked, and finally reached the border settlements in the lower country.

Van Benthuysen Springs are now covered by the Santa Fe building in downtown Dallas, at 1,100 Jackson Street. They flowed from a river terrace, probably from the Austin chalk beneath. In all probability they have now ceased flowing entirely, since recharge to their aquifer has been cut off by paving the area.

Kidd Springs (4) are located in the park of that name in southwest Dallas. Flowing from the Austin chalk at elevation 162 meters, the water drops over several small artificial waterfalls into a lake. In 1975 the flow was 1.3 lps.

In 1852 the French colony called Reunion was established in western Dallas, based upon a communistic or social democratic system. It was located at **Reunion Springs (3)**, which still flow 0.55 lps from the Austin chalk near Wedglea and Bahama Drives. The colony failed after a few years. A historical marker commemorates the effort.

In 1840 Colonel W. G. Cooke, while exploring a route between Austin and the Red River, stopped at some springs which he called **Cedar Springs (9)**. Three years later Dr. John Cole built a trading post here. The springs were in what is now Craddock Park in north central Dallas. They flowed from the Austin chalk, but are now dry. A group of large trees still marks the

spring site.

Grapevine Springs (10) flowed from gravel terrace material along Grapevine Creek one kilometer east of Coppell, in northwest Dallas County. The land surrounding the springs (Grapevine Springs Park) was given to the county in 1936. As described by the WPA in 1940,

> The park, covering twelve acres, is a natural beauty spot. The clear spring from which it takes its name is located in a miniature ravine formed by a small creek that flows in a winding course across the park from north to south. The spring itself is sheltered under an old-fashioned, rustic type well house. The spreading old pecan tree under which Sam Houston made his encampment stands about ten yards north of the spring. It constitutes a part of a large grove of pecan, elm, and oak trees with gnarled and serpentine old grapevines twisting about their trunks; they make the grounds a shady retreat for motorists.

In 1843 Sam Houston, or possibly his representative John Reagan, camped here while negotiating with the chiefs of the north Texas Indian tribes for a treaty. The treaty was eventually signed at Bird's Fort. The springs had been a favorite resort for the Indians for countless years previously. In 1846 Irenius Dunn lived near here. Many cattlemen and travelers knew Grapevine Springs well.

The park is now (1975) in a state of disrepair and is grown up in weeds, but there is talk of reopening it. The springs, however, cannot easily be brought back. The channels through which the various spring waters were directed are now dry. However, on December 27, 1975 there was a base flow of 3.5 liters per second in Grapevine Creek where it crosses Grapevine Springs Park. This indicates that other springs upstream are still flowing. Grapevines may still be seen in the vicinity. They have now given their name to the springs, the creek, the reservoir, and the city eight kilometers west.

Keller or **White Rock Springs (8)** flow from Austin chalk in the White Rock Creek channel. They are about two kilometers south of the Collin County line, at latitude 32°58' and longitude 96°48'. The Spaniard Moscoso may have stopped here in 1542. Many early settlers used the water from these springs. The spring flow was 1.3 liters per second in 1942. When the springs were visited by the writer in 1975, a storm was in progress, making measurement of the spring flow impossible.

Alpha Springs (12) are just northeast of the intersection of Alpha and Preston Roads in north Dallas. They were much used by early settlers in the area. On October 27, 1977, 2.0 lps seeped from Austin chalk in a grove of dogwoods, pines, and grapevines. The upper springs have been paved over.

Spring Valley Road in northeast Dallas crosses many spring-fed creeks which originate in Austin chalk. On November 6, 1977, the following discharges in lps were observed along this road:

White Rock Creek (near old Bird's Mill)	6.5
Valley Creek (1 kilometer east)	0.70
Branch of Cottonwood Creek (3 kilometers east)	1.3
Cottonwood Creek (4 kilometers east)	1.0
Floyd Branch (6 kilometers east)	1.9

In northeast Dallas County are **Big Springs (11)**, near the intersection of Big Springs and Jupiter Roads. The "big" springs which were so popular in early days are now a large number of very small springs in the Austin chalk on Spring Creek. On November 6, 1977, they were producing 8.2 lps, some of which was surface runoff from recent rains. The Big Springs church and cemetery are nearby. Large pecan, Texas oak, cottonwood, and sycamore trees fringe the creek. A housing development is about to swallow up the area.

In 1877 a family by the name of Balch settled at a trio of springs (7) southeast of Dallas. The springs soon became well known to travelers. Other settlers began to cluster around these vital sustainers, clear land, and begin families. The community, which took the name of the springs, is now a thriving city. **Balch Springs**, however, have dried up because of heavy well pumping nearby. Issuing from the Ozan sand, they were located near the intersection of Eastgate and Balch Springs Roads.

Harwood Springs (6) was the former name of the Kleberg community. The springs are about one kilometer northeast of the Kleberg post office on E. L. Enlow's place. Although they are now submerged by a small lake, Mr. Enlow reports that they still flow at a rate of about 1.0 liter per second. What he claims is the largest pecan tree in the state grows at the spring. It certainly may be, as two men reaching around it from opposite sides cannot touch hands. Doubtless the deep sandy terrace soil with water at a shallow depth has provided ideal growing conditions for the tree.

One kilometer southeast of Lancaster on Kellers Branch are **Indian Springs (13)**. Roderick Rawlins, who settled here in 1844, called the place **Hardscrabble** because of the shallow, rocky soils. On October 26, 1977, the springs were producing 1.7 lps from Austin chalk in a wooded area.

In northeast Lancaster, at the intersection of Park Place and Jefferson Street, were **Clear Springs (14)**. According to Mrs. William Bain of Lancaster, Madison Miller settled here in 1847, naming the place **Pleasant**

Run. Here was a store, post office, school, grist mill, and stagecoach stop. On October 26, 1977, only pools of standing water remained.

A settlement was begun in 1845 around **Cold Springs (5)**, six kilometers west of Lancaster. These springs rise from the Austin chalk along Tenmile Creek. For about 200 meters along the creek there is a fault zone of steeply dipping rock beds, which normally are only slightly inclined in this area. The springs emerge through these broken and tilted beds, flowing 0.51 lps in 1975. A short distance downstream the spring water helped to power a grist mill in early settlement days. The Cold Springs church is at the springs.

Honey Springs (15) were shown on R. A. Thompson's 1908 *Railroad and county map of Texas* in what is now south Dallas, near the intersection of Highways 12 and 342. A metal Indonesian battle axe found here was probably brought by early Spanish explorers. In 1841 General James Smith and company found an abundance of honey nearby when camped at the springs. Numerous springs in the vicinity issue from the Austin chalk. Most likely Honey Springs were in a tributary entering Fivemile Creek from the north, near the intersection of Mentor and Gracey Streets. On December 24, 1976, the discharge was 3.2 lps, one of the largest spring flows in the county.

DAWSON COUNTY

Dawson County originally had much flowing water, even on the plains. When the Spanish explorer De Salas came down Sulphur Springs Draw in 1632, he relied on the springs all along its course to provide water for his men and horses. At that time the Teya Apaches roamed this land. In the eighteenth century, on horses whose ancestors had been brought by the early Spanish explorers, the Comanches appropriated the area.

The larger, bold springs were in the breaks and canyons below the caprock of the plains, such as TJF Draw, Tobacco Creek, and Gold Creek Canyons. Here most of the evidence of early man's occupation of the area has been found.

When the water table began falling because of well pumping, the small springs on the plains, such as those along Sulphur Springs Draw, were the first to fail. In addition this draw and others above the caprock soon became filled in places with drifting sand during the dust storms caused by cultivation of the natural grass land. As a result these draws could not flow now even if the water table could be restored to its former level. More recently, even the springs in the canyons have been drying up. Pumping of ground water for irrigation is the primary offender. In 1974 the water table was declining by as much as 0.4 meter per year.

Most of the writer's field studies were made during the period June 12-17, 1975.

The springs issue or did issue from Pleistocene sand, Tertiary Ogallala sand, and Lower Cretaceous limestone. The water is of a calcium bicarbonate type, fresh, very hard, and alkaline.

Five kilometers south of Welch on Sulphur Springs Draw is Don Gibson's farm. Many burned-rock middens and worked flint fragments have been found in this vicinity. Very small springs or seeps (5) are reported to have flowed here, but were dry by 1900. The channel has been filled with modern sediment, and all of the draw is now in cultivation.

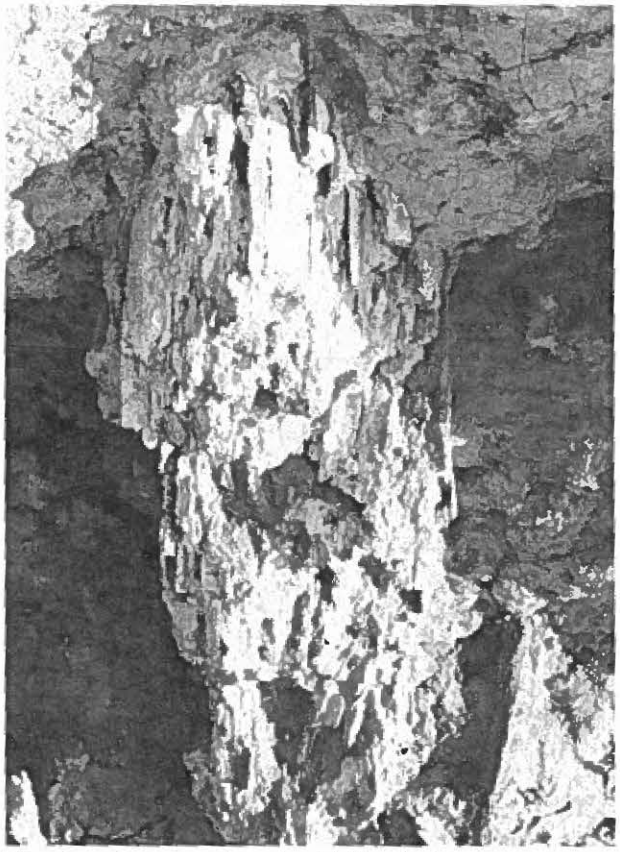
Rock Crusher or **Turner Springs (1)**, some of the few that still run in the county, are 11 kilometers south of O'Donnell at the R. E. Janes quarry. The remains of an Indian burial were found near here. The springs issue from Lower Cretaceous Edwards and associated limestones in TJF Draw at an elevation of 910 meters. Some consider them to be the source of the Colorado River, but of course many other springs contribute to the river. Cattails fill several bogs, shaded by salt cedars. The water feeds a recreational lake. Discharge records in liters per second are:

June 28, 1938	0.19	Oct. 4, 1978	1.9
June 14, 1975	0.63		

The records indicate that the springs are becoming stronger. The 1938 measurement was made during a drought, and that in 1978 was made after heavy rains. But the springs do appear to be maintaining their flow remarkably well, probably because there is no irrigation pumping in the vicinity. The discharge may also have been increased by injection of water brought from Rich Lake into the aquifer to the northwest of the springs by Ozark-Mahoning Co.

As shown in the table of Selected Chemical Analyses, the chloride and sulfate content of the water increased greatly between 1938 and 1978. The contamination may have been caused by oil-field and industrial activity to the northwest.

Two kilometers north of Rock Crusher Springs are **Earl Springs (4)**, on the John Earl estate, leased by Dan Turner. Here blue herons stalk minnows and crawfish among cattails and salt cedars. On October 4, 1978, 1.3 lps poured from Edwards limestone, feeding an earth tank and running for two kilometers. The water contains much chloride and sulfate. Many oil wells pump nearby.



Weathered mammoth tusk at Mullins Springs.

On the 54-section J. C. Mills ranch, managed by Duane Durham, are several springs which pour from Ogallala sand and Edwards limestone. The largest are **Tobacco Springs (7)** at the head of Tobacco Creek 14 kilometers south-southeast of O'Donnell. They were a favorite spot for outings and picnics in early days. The springs feed a small earth tank where algae, cattails, and willows abound. Hackberry trees, purple-blossomed horsemint, and cockleburs are also numerous. Raccoon and coyote tracks may be seen, and redwinged blackbirds fly overhead. On May 31, 1979, 0.13 lps of slightly saline water was passing the tank and flowing 0.8 kilometer downstream.

Nine kilometers east-northeast of Tobacco Springs are the smaller **Indian Springs (8)** in Indian Canyon. Here a prehistoric people lived in caves and left pictographs on the walls.

Eight kilometers south-southwest of Tobacco Springs are **Wet Tobacco Springs (9)**. Here the Slaughter ranch once had a corral, according to Mrs. Edna Miller, Borden County historian. The springs now have been reduced to a few pools with no running water.

Mullins Springs (2) were 23 kilometers east of Lamesa and six east-northeast of the Midway community in a canyon on William Reid's ranch. They flowed from Pleistocene deposits in which the remains of mammoths and large turtles are common. They formerly fed Sand Creek. (See Plate 13, e). Upstream from the spring site about 100 meters a mammoth tusk may be seen in the bank. The association of human artifacts indicates that this was a kill site of these extinct animals some 15,000 years ago. In 1902 J. W. C. Mullins settled here. The springs, which flowed until 1969, were a very popular spot for picnics and Boy Scout campouts. Their former location is still marked by large cottonwood trees.

Twenty kilometers southeast of Lamesa on Sulphur Springs Draw is Derry Trice's farm. Many Indian living sites have been found on the hills along the draw here, including metates, burned rock, and various artifacts. Very small springs (6) flowed here. By 1920 they had dried up, but in that year Trice's father found water at 0.3 meter in post holes. Now of course the water table is much deeper, and the draw is in pasture.

Also worthy of mention is a caliche pit (3) on Highway 180 two kilometers east of the Gaines County line. It is owned by M. C. Lindsey, a noted historian of the area. Fed by seepage, it contained water standing five meters below the surrounding land in 1975. Many ducks stop here.

DEAF SMITH COUNTY

Generally the land surface is so flat in Deaf Smith County that there has not been much opportunity for springs to develop. The exceptions were along *Tierra Blanca* (White Earth) and *Palo Duro* (Hard Wood or Cedar) Creeks, below the caprock in the northwest corner, and at Garcia and other large lakes or deep depressions. In nearly all cases the springs flowed from Ogallala sand and caliche, with a few issuing from Dockum sandstone.

As artifacts including Folsom projectile points have been found at the locations of many former springs, there is no doubt that early man lived at these sites as long as 10,000 years ago. As recently as 1907 Gould described "hundreds of springs" along Palo Duro and Tierra Blanca Creeks.

When Tierra Blanca Creek flowed constantly, it contained a series of pools of deep, clear blue water. As a consequence Hereford was for a time called Blue Water. But these pristine conditions were soon ruined by the settlers. Plowing up of the grassland loosened the fragile hold which the native grasses had upon the soil, and deep valley trenches began cutting headward in

the draws. The eroded soil was redeposited downstream, and soon the deep pools were all filled.

Removal of the grasses and their organic soil also caused damage to the soils' ability to absorb and recharge water to the underground reservoir. In addition well pumping, especially for crop irrigation, drew down water levels. From 1937 to 1967 the water table declined as much as 20 meters. As a result, nearly all of the county's springs have ceased flowing.

In early days ducks were abundant on brimming prairie lakes, fish were plentiful in the creeks, and wild plums and grapes were available for the picking. Herds of 100 or more antelope were common, as were bison, wild mustangs, wolves, turkeys, and prairie chickens. Most of these animals depended upon springs for their water and often food. With the failure of the springs and the loss of their natural habitat, many of these animals can no longer survive in the county.

In the past the larger lakes and deeper depressions were fed largely by springs and seeps from the very high water table surrounding them. As the water table has declined to great depths, the lakes are now nearly always dry except during heavy storms. Roads which still detour around former lakes, as at Mustang Lake north of Garcia Lake, could now pass straight through the dry beds.

The spring waters were of a calcium bicarbonate type, fresh, very hard, and alkaline. The content of fluoride or silica could be objectionably high. Because of the high fluoride content of its water, Hereford has been known as the "town without a toothache." The fluoride does prevent tooth decay, but in high concentrations can cause mottling of the teeth. The writer's field studies were made primarily during the period May 5-10, 1977.

In the northwestern corner of the county, below the caprock, many springs formerly flowed. One example was **Bridwell Springs (3)**, on the Bridwell ranch at latitude 35°05' and longitude 103°01'. This spring site is now marked only by dead and dying cottonwoods and an abandoned house.

In a willow grove on the H. D. Fowler ranch on Palo Duro Creek three kilometers west of the Randall County line were **Fowler Springs (1)**. One of the last Indian camps in the area was located here, according to Mrs. Fowler. Formerly ringed by grapevines and filled with fish, the springs stopped flowing in 1962. Another spring one kilometer downstream was a favorite for baptizing in early days. Four kilometers west was **Hodges Spring**, which flowed 1.3 lps in 1938. Now dry, the site is still marked by dead trees. Many other springs formerly flowed along Palo Duro Creek. Clyde

Big Springs.

Allred remembers that until about 1927 Palo Duro Creek flowed downstream from Hodges Spring, and North Palo Duro Creek flowed below Highway 809.

The only springs which still flow in the county are **Big Springs (4)** on Tierra Blanca Creek on the Gault ranch, seven kilometers west of the Randall County line. Pedro Vial may have stopped here in 1789 on his return to Santa Fe from San Antonio. Here Joe Cox built his dugout in 1887. A few years later, when the springs were a camp on the T-Anchor ranch, they were producing 32 liters of water per second from an elevation of 1,120 meters. In 1937 the flow had been reduced to 0.95 lps. In May 1977 it was 0.32 lps, flowing between a series of turtle-filled pools in a pasture. According to Rachel Hunter of Hereford, many cows used to get bogged down in the swamp surrounding the springs. Cottonwood and elm groves surround them.

Five kilometers southeast, on the Gerald Parker ranch, were **Parker Springs (2)**. A favorite haunt of prehistoric Americans, they flowed from the base of a caliche caprock. They dried up in 1969 and have not flowed since. The site is marked by a dead tree, a few shrubs, and a small pool of standing water.

G. L. Gillespie's 1875 *Map of portions of Texas, New Mexico, and Indian Territory* and G. F. Cram's 1890 map of Texas showed **Ojo Frio** or **Cold Spring (8)** on Frio Creek a few kilometers upstream from its junction with Tierra Blanca Creek. Clyde Allred of Hereford remembers when Frio Draw flowed in its lower 6 to 8 kilometers. The springs ceased flowing in the 1930s.

Sulphur Springs (7), in Sulphur Park on the old L. R. Bradly farm, were on Tierra Blanca Creek just upstream from its junction with Frio Draw. At these sulfur and freshwater springs George Jowell settled in 1887. He used a hydraulic ram to pump irrigation water from the springs. According to Bill Bradly of Hereford a lake formerly existed here, which was very popular for boating, swimming, and fishing. The springs failed in the mid-1940s, and most of the cottonwoods have now

died.

G. L. Gillespie's 1875 map showed a **Punta de Agua** or **Source of Water (6)** on Tierra Blanca Creek about nine kilometers west of Hereford. Below this point the stream flowed constantly, and is still lined with many cottonwood trees. In early days it was difficult to ford Tierra Blanca Creek because of the large flow. According to Clyde Allred the creek flowed strongly until about 1925, when it began to falter. George Watson of Miami spent many happy hours as a boy fishing in the creek near Hereford. After about 1940 there was no flow except from surface runoff.

The Santa Fe expedition traveled up Tierra Blanca Creek in 1841 from the Randall County line into New Mexico, where they were captured by Mexican forces. They camped at the more important springs, their last stop in Texas being at the **Escarbada (5)**, four kilometers east of the state line on Tierra Blanca Creek. The name indicates that small springs or seeps could be opened up by scraping out a hole here. The XIT ranch used these springs in 1890. Their division headquarters house which stood here has now been moved to Lubbock. The springs, which were on the present Reinauer ranch managed by Dean Watson, as well as others a short distance downstream, are now dry. But according to Watson the water table is still very shallow along the creek.

Ojitas de Garcia or **Little Garcia Springs (9)** formerly issued from Dockum sandstone in a draw two kilometers west-northwest of Garcia Lake. This was formerly a favorite Indian campground. Gillespie depicted the springs on his 1875 map. Thrall's 1879 *Map of Texas* called them **Ojitas de la Carriza** or **Little Reed Springs**. In 1938 five seeps were noted here by the Texas Board of Water Engineers. Two large hackberry trees at the springs, known as Big Trees, were a popular picnic spot many years ago. The springs are now dry, but prairie dogs still frolic among fields of yellow senna flowers in the spring season. The downstream Lake Garcia is also quite dry now.

DELTA COUNTY

Delta County's springs issued chiefly from the Wolfe City and Pecan Gap sands along the North Sulphur River, the Nacatoch sand along the South Sulphur River, and terrace sands along both. There also appears to have been seepage in the past from silts in the Marlbrook formation, which kept many streams flowing continuously.

The springs were used as living sites by early Americans for many thousands of years. In historic times an agricultural people who cultivated maize, beans, and squash lived near the springs in thatched houses. Animal life was abundant. A three-meter-long panther was once killed in the county. Fish-laden natural lakes provided a haven for ducks and geese. Passenger pigeons darkened the sky as late as the 1870s. Fruits such as strawberries, blackberries, dewberries, horsemint, and honey were abundant.

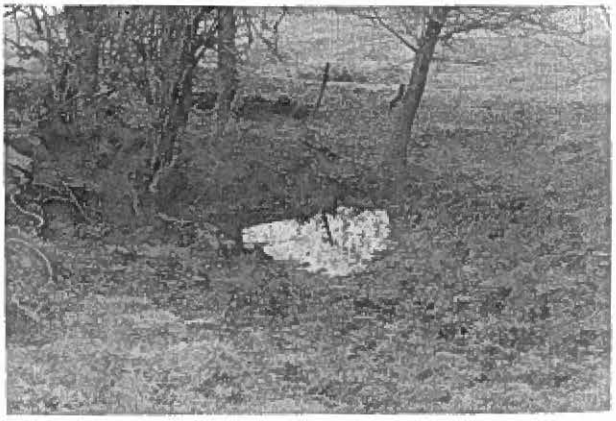
All this has greatly changed now. Ditches dug chiefly in the 1920s drained all of the lakes and sediment from plowed fields filled them. Flowing and pumping wells have so lowered the water table that few springs still flow, and these are now only seeps. The wildlife which depended upon the springs and lakes has largely disappeared.

Most of the writer's field studies were made during the period November 3-7, 1977. As this was a very wet period, the observed discharges were probably higher than normal for this season. The water is, or was, chiefly of a sodium bicarbonate type, fresh, soft, and very alkaline.

Four kilometers southwest of Ben Franklin, in the vicinity of the 1859 Giles Academy, were **Giles Springs (5)**. Just east, on the Harley Waller place, the remains of an old "fort" were discovered in 1830. Consisting of an earth embankment surrounding 0.8 hectare of land, this may have been the work of the mound-building people who once lived here. A lake formerly existed on the nearby North Sulphur River. Camp Rusk was located at the springs during the Civil War. They are now only seeps from the Wolfe City sand and Pecan Gap chalk. They feed stock ponds of clear water containing many fish and turtles and shaded by pecan trees. Several historical markers may be found here.

In the Mount Joy community five miles northeast of Enloe are **Mount Joy Springs (1)**. Many projectile

Mount Joy Springs.



points, celts, and wooden implements found here testify to the springs' long use by prehistoric people. Buford Lake, formerly fed by the springs, was drained in 1927. An Indian mound was found 2.5 kilometers northwest. The springs, on the road from Cooper to Paris, were the site of a gin, saw mill, and grist mill. According to owner J. C. Gillean and Emmett Gillean, they were bricked up in the 1920s and produced a stream which ran 100 meters or more. Now they are only seeps from Pecan Gap chalk which maintain a pool of water shaded by willows and hackberries. A similar seep exists one kilometer west. Many shallow wells in the area have contributed to the demise of these springs. A nearby historical marker relates to the settlement of the springs in 1854.

Nine kilometers northeast of Enloe numerous seeps (2) drain into the dredged channel of the North Sulphur River from Quaternary sand on top of Marlbrook marl. Spring-fed lakes formerly existed here. Numerous Indian artifacts indicate that this was a popular spot in past millenia.

One kilometer south of the old community of Charleston and 14 east of Cooper were **Kichai Springs (4)**. A Kichai village was located here. In 1848 the early Charleston settlers made much use of the springs. Now they are only seeps from river terrace sand into ponds and creek channels.

Miller Springs (7) were at the Miller archeological site seven miles south of Cooper. Artifacts found here indicate that at various times during the last 4,000 years early Americans lived at these springs. Severe gullying has exposed the Nacatoch fine sand from which the springs formerly flowed, but no longer do. Persimmons are common. To the southwest were Jordan's Lake and a salt lick, popular in prehistoric times.

Doctors and Johns Creeks west of Cooper formerly ran continuously, probably fed by seepage from the Marlbrook marl. The last Indian village in the county was located on Doctors Creek four kilometers southwest of Cooper. In 1879 there was always a flow in Doctors Creek. A small reservoir on the creek four kilometers west of Cooper was used for swimming, fishing, picnicking, and baptizing.

DENTON COUNTY

The springs of Denton County have been used by mankind for a very long time. In fact, one of the earliest records of man in America is located here. Charcoal from a hearth in a river terrace near Lewisville, associated with Clovis projectile points, was found by radiocarbon dating to be at least 38,000 years old. This site is now beneath Garza-Little Elm Reservoir. Some archeologists believe that other artifacts found in the area are several thousand years older. These people must have made use of the springs in river terraces along Elm Fork and Little Elm Creek. The climate at that time was warm and interglacial, with giant tortoises, alligators, tapirs, and palmettos which today are found only much farther south.

Around 1700 the Wichitas began to move into the area from the north, settling near springs along the creeks. From 1830 to 1843 other tribes such as the Ionies, Kichais, and Caddoes, forced out of their eastern lands, also lived here briefly before being exterminated or evicted.

Most of the springs are located in the eastern half of the county, flowing chiefly from the Woodbine sand and river-terrace sand and gravel. Denton is on the western edge of this area. Early settlers found water a great problem west of here, as Bates (1918) says,

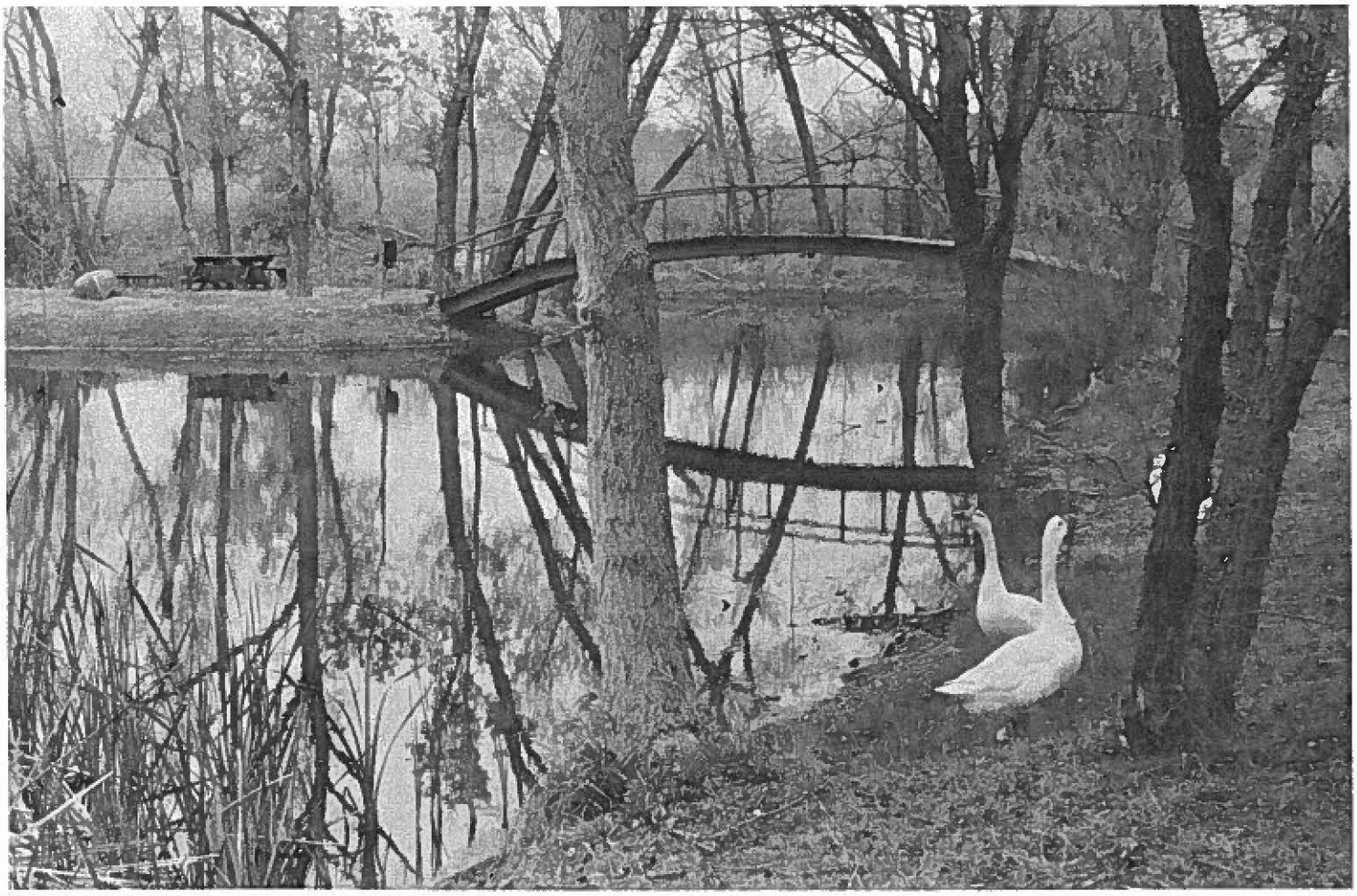
> [Hiram Harris] settled on Hickory Creek, about half a mile from where Denton now stands. . . .
>
> In regard to the condition of the country at that time [1850], water was scarce and a great many people hauled their drinking water from standing pools in the creek beds. It was very unhealthy, consequently there was a great deal of sickness. You ask why we left Denton. We left hoping to better ourselves, both financially and physically.

Water tables have declined greatly in most of the county since early settlement times. For example, at the North Texas State University golf course southwest of Denton there was a Wichita village and certainly some springs. The springs have long since ceased to flow. Indian Creek and Willow Springs Branch in southeastern Denton County were formerly spring-fed flowing creeks, favored as campsites by the Wichitas. These streams are completely dry now.

The spring water is usually of a sodium bicarbonate type, and is fresh, soft, and alkaline. The content of sulfate and fluoride may be high. Down dip (to the southeast) the water in the Woodbine sand becomes increasingly mineralized. Hence the spring water is of better quality than the deeper well water to the southeast.

Most of the writer's field studies were made on April 5-10, 1976.

In the Civic Center Park in Denton are **Denton Springs (1)**. Flowing from Grayson marl, they are now largely covered by concrete-lined channels. Some of the larger ones enter the channel through a pipe where Pecan Creek crosses Oakland Avenue. These springs



Lake fed by Brandon Springs.

were very popular with the Indians and with early Anglo-American settlers. The discharge was 1.3 liters per second on April 5, 1976, and 2.6 on December 23, 1977.

Three kilometers southwest of Sanger, on the west bank of Duck Creek just below an old cemetery on John L. Sullivan's farm, are **Mud Springs (13)**. Lt. F. C. Bryan's party probably stopped here in 1849. As the springs were shown on several old maps, they must have been important to the early residents. They flow from the Fort Worth limestone conglomerate 15 meters above the creek. They pass over the underlying muddy shales, which undoubtedly is the reason they were called Mud Springs. Reported to flow much more strongly formerly, the springs have formed travertine deposits on the bluff. Maidenhair ferns and poison ivy surround them. The discharge was 0.20 lps on July 2, 1976, but only a seep on December 23, 1977.

Seven kilometers southeast of Sanger, northeast of the cemetery of the same name, are **Gribble Springs (3)**. Flowing 0.35 lps from terrace gravel on A. R. Sides' property in 1976, the springs furnish water for his home and those of several neighbors. A Wichita village was located here in early historic times. In 1871 the settlement of Gribble Springs grew up around the springs, but was destroyed by a tornado in 1896. About 1915 a cotton gin was using the water. A large elm tree stands at the springs.

Brandon Springs (2) are 11 kilometers northeast of Denton on Harry Down's place. Burned rock middens and projectile points found here disclose very ancient use of the springs by man. In 1976 they flowed 0.10 lps from Grayson marl in a grove of woods into a recreational lake. Grace (1944) described them as follows:

> As early as 1873 and earlier perhaps a man by the name of Brandon owned the land on which was located the famous Brandon Spring. It is . . . just North of the edge of the bottom along Clear Creek. Not much is known of Mr. Brandon and in a few years he sold out and moved away. The Brandon Spring was known far and wide. It produced everlasting water, pure and good. Many people hauled water therefrom in the early days for domestic use. It was of great benefit to travelers being situated on the direct road from Pilot Point to the town of Denton, which road passed through Toll Town [Green Valley] and was about two miles southwest of that place.

Dripping Springs (4), just northwest of Pilot Point, issue from Woodbine sand. In 1976 they barely flowed (0.05 lps), but as Bates (1918) pointed out, they were

once quite an attraction:

> At an early day there was a large grove of post oak trees extending out into the prairie on this high ridge which could be seen for many miles, and especially from the Collin County ridge. There being no roads people traveled by course, guided by visible objects in the distance, and this grove was used as a pilot to the traveler. From this fact it received the name, Pilot Point, attracting its first settlers. Its first settlement was made in 1846. At that time there was a spring just northwest of the grove which furnished water for camping purposes, it being a favorite place for Indians, rangers, and cowboys.

Spring Hill Springs (7) are 12 kilometers south-southeast of Pilot Point and just southwest of Antioch church. Flowing 0.65 lps from Woodbine sand in 1976, they were once the center of the Spring Hill community.

Sixteen kilometers east of Denton and just north of Highway 380 are **Justus Springs (5)**. Named for the family which formerly lived here, they flow from terrace sands. Residents of the old Sand Town settlement used them as early as 1862. Although they are reported to have formerly flowed copiously, they were reduced in 1976 to little more than seeps (0.05 lps). The water is high in iron content.

Twenty-five kilometers east-northeast of Denton at Good Hope cemetery are **Rue Springs (6)**, named for the family which settled here in 1854. Many springs in this neighborhood issue from a shallow gravel beneath silt and clay in the Eagle Ford formation. The ones just west of the cemetery are of great interest, as they were reportedly deepened by the Wichitas to form a shallow well. Mr. G. C. Rue, an old resident, states that these springs formerly flowed more strongly than the 1976 discharge of 0.12 lps.

Twenty-two kilometers east-southeast of Denton on Highway 720 are **John House Springs (8)**, at latitude 33°10' and longitude 96°54'. Flowing from terrace sand and silt, their discharge of 1.0 lps in 1976 was measured at the highway, and would be slightly higher if evaporation from several upstream stock ponds were added. These springs were used by John King and his family and other settlers at Little Elm from 1844 on. For many years the settlers met here on wash day. Other springs formerly used by this community are now under Garza-Little Elm Reservoir.

Eight kilometers east-southeast of Lewisville, on George Underwood's ranch, are **Willow Springs (14)**. According to Clarence Crumley, a neighbor, residents formerly came great distances to obtain the spring water. Willow Springs church once stood here, and Willow Springs school was two kilometers northeast. The water was collected in a tile pipe from Quaternary gravel, forming the source of Willow Springs Branch. Now the springs are beneath a lake.

Lockhart Springs (9) are 10 kilometers northwest of Lewisville. Issuing from Woodbine sand at 0.10 lps, they are just north of the Chinn's Chapel church and cemetery. Bates (1918) described them and other nearby springs well:

> Chinn's Chapel had its beginning in 1845. . . . Here there were four springs that furnished water for the settlement that clustered round them — the Lockhart Spring, **Murphy Spring**, and the two **Loving Springs**. The settler well understood that he was to haul water from these springs or from Hickory Creek, as no wells had been dug at that time. These springs were a very important factor in making this among the first settlements. Nearly all the early settlers settled on creeks or near springs.

Copperas Springs (10) are located 12 kilometers northwest of Lewisville in Copperas Canyon on Hickory Creek. They were probably used by prehistoric men and women some 40,000 years ago. The name *Copperas* refers to the hydrated iron sulfate which is common in the Woodbine sandstone here. In 1976 the springs discharged 0.30 lps into a small recreational lake at an elevation of 165 meters above sea level.

Pilot Knob can be seen just west of Interstate 35W, 10 kilometers southwest of Denton. This is said to be where Sam Bass and some of his gang holed up in the 1870s between train robberies. On the west and southwest sides of the knob some springs (11) flowed from iron-bearing Woodbine sand on top of Grayson marl in a post-oak forest. They have now dried up except for some water standing in holes. A well on the knob has probably contributed to the lowering of the water table. The cave in which Bass lived has since been blasted shut.

DICKENS COUNTY

The northwest corner of Dickens County lies on the High Plains or *Llano Estacado*. Translated, this means *Stockaded* or *Palisaded Plains*, because the escarpment, viewed from below, looked like a Spanish fortress to the early explorers. The term *Staked Plains*, although it has come into common usage, is a misnomer. The High Plains are underlain by Tertiary Ogallala sand, gravel, and caliche. Abundant springs once flowed from this formation all along the caprock escarpment, but most have disappeared because of the heavy draft of irrigation well pumping upon the groundwater reservoir. From 1959 to 1968 the water table in the

Ogallala formation declined as much as 7.0 meters. Some springs still issue from Triassic Dockum sandstone which lies beneath the Ogallala and is recharged from it.

The remainder of the county lies in the Rolling Red Plains. Here springs trickle from Permian gypsum and sandstone in the Quartermaster, Whitehorse, and Cloud Chief formations. A few springs emerge from Quaternary windblown sand deposits and river terrace sand and gravel.

In addition to the decline of the water table, there has been catastrophic gully erosion in modern times. This choked many stream channels, filling the once-deep holes as early as 1914 and burying some springs.

The springs were popular with prehistoric people as well as the early settlers. The usual vegetation at the springs includes willow, hackberry, chinaberry, and salt cedar trees, plum thickets, rushes, and cattails. On the nearby slopes are usually cedar and mesquite trees. Shinnery predominates in the very sandy areas.

Originally Rustler, Grapevine, Duck, and the other streams draining from the caprock were beautiful running brooks. Flocks of ducks stopped at the water holes along Duck Creek. During the droughts which occurred in 1886-93, 1898-99, 1930, 1934, 1943, and 1952-56, many springs stopped flowing temporarily. Unfortunately, the decline has been permanent for most springs. The floodwater retarding structures built by the U. S. Soil Conservation Service in the Duck Creek watershed have aided in recharging the groundwater reservoir. But they cannot be expected to bring the springs back to life.

The spring water is generally of a calcium bicarbonate type, fresh, very hard, and alkaline. The content of fluoride may be high. Oil-field contamination in the past probably caused the sodium chloride content of the water to increase in some cases. In gypsum areas the calcium sulfate content is usually high.

Most of the writer's field studies were made during the period August 8-13, 1979. As most areas of the county received around 10 centimeters of rain during the preceding two weeks, the observed spring discharges are probably higher than normal for this season.

On Guy Goen's ranch northwest of Dickens, leased by Bedford Fry, several springs trickle or did trickle from Dockum sandstone. **Browning Springs (16)** were five kilometers northwest of Dickens in Hobble Scobble Canyon. They are now beneath a floodwater retarding structure.

Another spring (17) is eight kilometers northwest of Dickens. On August 11, 1979, it produced 0.20 liter per second, running about 100 meters before disappearing. Cottonwood trees grow here, and a short distance downstream introduced aspens thrive. About three kilometers downstream a prehistoric people left mortar holes in the sandstone bedrock. Turkeys and pheasants, released nearby by the Duck Creek Hunting Club, make their home at the springs.

Pecan Grove Spring (15) was nine kilometers southeast of McAdoo. It has about disappeared, although a seep still occurs in wet weather.

On Grapevine Creek and its tributaries in northwestern Dickens County are or were several springs on Roy and Lynn Moore's ranch. All flow or flowed from Ogallala sand on Triassic sandstone. **White House Springs (14)** were seven kilometers northeast of McAdoo. On August 11, 1979, they were dry, but reportedly seep in wet weather.

Four kilometers downstream were other springs (12). On September 20, 1938, they produced 0.95 lps. On August 11, 1979, there were only seep-fed pools, with no running flow. The pools were being filled in, to be planted to alfalfa. Frogs and whirligig beetles were swimming in the water. Collared lizards or mountain boomers, prairie dogs, burrowing owls, antelope, and turkeys frequent the site. Grapevine Springs, near the mouth of Grapevine Creek, are similar.

Six kilometers north-northwest of Glenn is another group of springs (13) on the Moore ranch. On January 31, 1969, they discharged 1.0 lps.

Cottonwood Springs (11) are one kilometer west of Afton on Eva Collier's farm. An Indian village was located here, and later the Matador ranch's Cottonwood camp. The source of Cottonwood Creek, the springs produced 1.6 lps from Dockum sandstone on September 19, 1938. On August 11, 1979, after heavy rains in the preceding two weeks, the discharge was 1.9 lps. Many shallow irrigation wells pump nearby. Disastrous erosion has choked the creek channel with sand, converting the flood plain into a series of swamps. Minnows dart among the bulrushes and cattails. Raccoon and coyote tracks are numerous.

One kilometer north of Afton are **Patton Springs (1)** on Bundy Campbell's property, leased by Bobby Harris. In 1876 a buffalo hunter named Patton camped here, stacking thousands of hides nearby. In 1879 the mail road from Ft. Elliott and Teepee City passed Patton Springs. In 1918 an earth tank at the springs was used for baptisms. On September 19, 1938, the discharge was 1.4 lps. Now the springs are covered by the waters of a lake which was used for crop irrigation, but is presently used primarily for fishing. Many birds and bullfrogs make their home among the willows, cattails,

Water troughs fed by Shinnery Springs.

and rushes.

Jackson Springs (10) were 10 kilometers north of Dickens on the old Jackson place, now owned by Felix Ramirez and leased by Curtis Osborn. In 1877 pioneer surveyor O. W. Williams stopped here. In the 1920s Eva Collier lived here. She reports that the springs were intermittent then. On August 11, 1979, they were dry and the creek channel was filled with sand.

Sanders Springs (2) pour out of Quaternary sand eight kilometers east-northeast of Afton on the Moss ranch, managed by Larry Burkes. They were the site of Red Lake Camp, where Matador roundups were once held. A dugout from here has been placed in the Lubbock museum. Many small springs flow in Sanders Hollow. On August 9, 1979, eight days after a 10-centimeter rain, the discharge was 10 lps. Many seep-willow baccharis shrubs with their white flowers fringe the water. Turtles and small fish inhabit the pools, while doves and dragon flies dart overhead.

Shinnery Springs (6) are in a remote area 10 kilometers southwest of Dumont on the Pitchfork ranch, managed by Jim Humphreys. This was a favorite campground of Quanah Parker's Comanches. Early settlers over a large area hauled water from these springs. According to Humphreys, an old trading post was located here. The water trickles from many seeps in Quaternary sand and gravel on top of a hard conglomerate layer about 0.5 meter thick. Beneath it are Permian shales.

On August 10, 1979, 0.30 lps of fresh water poured from Shinnery Springs, feeding four water troughs and running for 200 meters. Dark gray soils indicate that a swampy area once surrounded the semicircle of springs. The sites of several former seeps or springs, not flowing on this date, could also be seen. cottonwood and huge willow trees shade the site. Doves frequent the vicinity. Bees, wasps, and butterflies sip the water. The adjacent sandy hills are covered with shinnery and mesquite.

Dripping Springs (9) are nine kilometers south-southwest of Dumont on Don Brothers' ranch. The Comanches also favored these springs as a campground. The springs were a favorite stop for travelers in early days, and were used by many residents in the Dumont area. They are similar to Shinnery Springs, but not as large. The water drips from a Quaternary conglomerate into a red-bed canyon.

Near Dickens are several good springs which pour from Dockum sandstone on Permian shale. **Law Springs (8)** are four kilometers northeast on John McLarty's ranch. They were popular with early nesters in the area. The springs are curbed and the water piped to troughs.

Dickens or **Crow Springs (3)** are one kilometer northeast of Dickens on city property. Thousands of projectile points, metates, and other artifacts found here indicate that this was a favorite living site in past millenia. The springs were given to the city by Dr. M. S. Crow with the thought that they should be developed as a water supply. They were never used for this purpose, but many early residents hauled water from the springs.

Dickens Springs are undoubtedly the most beautiful in the county. The fresh water flows at an elevation of 760 meters from one relatively large spring and many smaller ones in a high bluff of Dockum sandstone at the head of a ravine. Maidenhair ferns drape the dripping rocks. (See Plate 10, e). Cottonwood trees and grapevines frame the picture. Many names and dates have been carved in the cliff rock. A stairway leads down to the springs. Doves fly overhead and water striders dart across the pools. On the ground is a litter of 22-caliber cartridge cases where "sportsmen" have idly shot anything that moved. On September 21, 1938, and September 11, 1967, the discharge of the springs was 0.95 lps. On August 9, 1979, after much rain, it was 2.4 lps.

Less than one kilometer southeast of Dickens Springs is a roadside park on Highway 82. The water of a very small spring here is piped to the park. It is used by thousands of travelers annually. On September 21, 1938, 0.19 lps poured from the pipe. On August 9, 1979, the flow was 0.13 lps.

Mitchell Springs (19) are three kilometers east-southeast of Dickens on Billy George Drennan's ranch. Many projectile points and other ancient artifacts have been found here. An old Matador ranch dugout was located at the springs. Two cowboys killed each other in a duel here and were buried nearby. Later a little girl

who died here was also buried near the springs.

On August 12, 1979, Mitchell Springs produced 0.14 lps. Maidenhair ferns and mint grow in the water, while cottonwood trees and grapevines shade the site. The springs supply fresh water to an attractive stone cabin and a steel trough. Goldfish swim among the water milfoil. Water striders skate on the surface.

About two kilometers south of Mitchell Springs are the similar **Askins Springs**. They are on Robert Collier's ranch.

Eleven kilometers east of Dickens are some springs (7) on Little Croton Creek. They drain from Quaternary sand on Quartermaster gypsum and sandstone. On August 10, 1979, 2.1 lps was passing Highway 82. There was also a flow of 0.19 lps from a drain pipe in the highway here. Raccoon tracks may be seen around the pools, where minnows dart.

Davidson Springs (4) were four kilometers north of the Pitchfork ranch headquarters near the King County line. They were depicted on G. L. Gillespie's 1876 *Map of the western territories*. In the 1880s the Pitchfork ranch had a dugout here. Only seeps were present on August 10, 1979.

A similar spring which once flowed at the Pitchfork headquarters on the South Wichita river was also only a seep on this date. Turkey and raccoon tracks were abundant beneath the cottonwood trees. The channel has been completely filled with sand from upstream gully erosion. Four kilometers west, however, where the South Wichita crosses Highway 82, there was a flow of 1.3 lps on August 10.

Several other very small springs trickle on the Pitchfork ranch in the Croton Breaks in southeast Dickens County. One group is **Molly Bailey Springs (5)**, which seep from Whitehorse sandstone in a canyon about 11 kilometers north of Girard.

Six kilometers north of Spur and just southwest of Soldier Mound are **Flag Springs (24)** on Duck Creek on L. T. Smith's ranch. Soldier Mound or Anderson's Fort was used by Col. R. S. Mackenzie during his campaigns against the Comanches in the early 1870s. His troops no doubt made use of the spring waters. In 1883 a store and post office were located here. The springs were named for the flags (wild irises) which grew here, but are now gone.

Later there was a popular swimming hole at Flag Springs. Now the holes are largely filled with sediment. On August 11, 1979, a few live pools containing catfish existed, but no running flow. Cottonwoods and seep-willow baccharis shrubs are present in addition to the usual spring vegetation. Tiger beetles prowl the pool edges, and raccoon and coyote tracks are abundant. Many shallow irrigation wells along Duck Creek have no doubt reduced the spring flow.

In front of the Texas Highway Department office in Dickens is a Dockum sandstone boulder containing a weathered mortar hole. This boulder was taken from a sandstone ridge three kilometers northwest of Spur and on the north side of Dockum Creek. This site is now more than one kilometer from the creek. But at the time the mortar hole was ground by an ancient people, the spring-fed creek (18) was probably very close. Dockum Creek is now dry in this vicinity.

Gyp Springs (23) are on Red Mud Creek in southwest Dickens County, one kilometer north of Highway 261 on Paul Hagins' ranch, leased by Darrel Walker. They issue from a high bluff of Quartermaster sandstone and gypsum. The Red Mud archeological site, dating from Neo-American time, is a short distance upstream. A store, dance hall, and buffalo hunters' camp were once located here, according to neighboring rancher Jack Moore. Buggy rides to Gyp Springs were popular with courting couples. Early settlers in the area hauled the water to their homes.

Around 1900 Gyp Springs are reported to have filled a 2-inch (5-centimeter) pipe. This would amount to at least 1.3 lps. A rattlesnake den in the bluff was later dynamited. Moore believes that this was the cause of a reduction in flow. On August 13, 1979, the discharge was 0.32 lps, which ran about 400 meters before disappearing. Cottonwoods shade the creek channel. An owl perches on the bluff. Raccoon and coyote tracks are numerous. Tadpoles swim in the pools.

Dockum Springs (22) are 14 kilometers northwest of Spur on Pete Dobbins' ranch. An archeological site on a nearby hill indicates that people of the Archaic period and later lived here. Dockums, the first Dickens County seat, was located here. The Dockum Springs school was two kilometers west. On August 12, 1979, there were only some pools of live water in Dockum Creek adjacent to a bluff of Dockum sandstone which dips upstream. Frogs swim in the water.

Spur Headquarters Springs (20) are nine kilometers southwest of Dickens on Jim Barron's Spur Headquarters ranch. In the late 1870s residents of the *Espuela* (Spanish for Spur) community used the water. In 1887 the spring waters were used for the first irrigation in the county, on the Spur ranch gardens. One of the two main springs emerges in a springhouse and still supplies water to the headquarters buildings.

The fresh water trickles from Triassic sandstone and

conglomerate on Permian shale. Discharge records in lps are:

Oct. 7, 1938	0.50	Aug. 12, 1979	0.13
Mar. 7, 1969	0.38		

Dark gray soils in the vicinity indicate that the springs were more extensive in the past. Pheasants and frogs are at home here.

Rock House Springs (21) are eight kilometers west of Dickens, also on the Spur Headquarters ranch. Here was a trading post in the buffalo-hunting days of the late 1870s. A freighter is said to have shot the storekeeper in an argument over prices. He was buried at the springs. Several Indian sites have been found nearby. On August 12, 1979, there were pools of water below a ledge of Dockum conglomerate on Permian shale. Many raccoon tracks may be seen. Nearby is a small grove of post oaks.

DIMMIT COUNTY

Most of Dimmit County's springs flow or did flow from the Carrizo sand in the western part of the county. A few trickled from other Eocene sands such as the Indio, Bigford, and El Pico. These formations dip toward the east at about 12 to 30 meters per kilometer. A few springs also discharged from river terrace sand and gravel.

For many thousands of years Coahuiltecan Indians and their predecessors lived at the county's springs and spring-fed creeks, most of which flowed. The remains of Pleistocene elephants, such as were hunted by Paleo-Indians, have been found in the bog which surrounded Carrizo Springs. Many fierce battles were fought by the Indians for their springs when the whites began to move into the area.

The springs suffered greatly when flowing wells began to be drilled. The first was at Carrizo Springs in 1884. In 1910 the Winter Garden ranch north of Carrizo Springs advertised that there were 300 flowing wells within 10 miles (16 kilometers). All of them flowed from 6.3 to 63 liters per second from the Carrizo sand. They had a pressure head of as much as 12 meters above the land surface. By 1920 most of them had stopped flowing, and the land boom was over in Asherton, Brundage, and other nearby towns.

As most of these wells were allowed to flow continuously, it was not long before the hydrostatic head on the springs, and their discharge, was greatly reduced. But irrigation pumping continued the onslaught on the groundwater reservoir. Pumping for irrigation of crops reached a maximum of 0.025 cubic kilometer in 1969, after which it declined because of increasing pumping lifts. From 1925 to 1970 the artesian water table in the Carrizo aquifer declined as much as 75 meters. In the Carrizo outcrop area the decline was less, but still disastrous. As a result, nearly all of the once-plentiful springs of the county are now gone.

In addition, uncontrolled soil erosion washed huge quantities of sand into the creeks. Many once-deep waterholes and springs were thus buried.

The springs and deep spring-fed creeks formerly harbored huge catfish, crawfish, mussels, frogs, snakes, and various insects. Feeding upon this aquatic life were enormous alligators, some of which attacked men, panthers, bears, armadillos, raccoons, coyotes, bobcats, cranes, herons, ducks, and killdeers, to name a few. Dependent on the springs for water were herbivorous animals such as deer, huge turkeys, javelinas, beavers, and others. Rocks around the springs were draped with maidenhair ferns. The waters supported aquatic plants such as water shields, marsh purslane, and water lilies. The pools were shaded by willows, seep willows, hackberry and live oak trees. When the springs dried up, most of this complex assemblage of plants and animals perished. Often a stand of live oaks persists for many years after a spring has disappeared, but eventually it too dies in the face of a constantly falling water table.

The spring waters are generally of a sodium bicarbonate type, fresh, moderately hard, and alkaline. The content of silica may be high.

Most of the writer's field studies were made during the period January 28 to February 3, 1979.

Carrizo Springs (1) are a line of springs along the west side of Carrizo Creek from six kilometers southwest of the city of Carrizo Springs to four kilometers north-northeast. They were named for the reeds or cane which grows abundantly here. They trickle from Carrizo sand along a fault, where Bigford clay forms an underground barrier, forcing the water to the surface. In 1689 the Spaniard Alonso de Leon probably refreshed himself here when en route to Fort St. Louis in present Victoria County. In 1718 Martin de Alarcon (Celiz, 1935) described the springs thus:

> On the 10th [of April], we left the above-mentioned spot [Las Rosas de San Juan], and went to that of El Carrizo, which is about seven leagues distant. This road is level for the first three leagues; the rest is hilly in places with some ravines. There is a spring at this place, which is very lovely, owing to the willows extending up the creek, although the water itself is not sufficient for tillage.

The sites of many Indian villages have been found here, and the Indians resisted eviction fiercely when the

Water-worn Carrizo sandstone at site of former waterfall, Carrizo Springs.

whites arrived. In 1865 Captain Levi English brought 400 settlers to the springs. In spite of Alarcon's prediction to the contrary, the spring waters were used to irrigate a garden near where the railroad station later stood. In the 1870s an Army camp was located here.

Until about 1929, Carrizo Creek ran constantly, containing large catfish. Where it crossed a sandstone outcrop on Mrs. Bill Johnson's ranch, it formed a waterfall which was a favorite bathing spot. Mrs. Blanche Eubanks of Carrizo Springs used to drink from the springs at the railroad station, where only a stagnant pool exists now. Deep fish-filled holes existed especially at the old Carrizo Park south of town, now owned by Ray Mitchell. When the spring flow began to slacken, the creek channel soon filled with sand from uncontrolled soil erosion. During the drought of the 1950s the large pecan, willow, and mesquite trees surrounding the springs all died, according to Georgina Manter. A few hackberry trees still survive.

On December 30, 1901, the discharge of Carrizo Creek near Carrizo Springs (not including the northernmost springs) was 37 lps. In 1892 the flow of the springs was measured by Peale (1894) as 7.4 lps. On February 1, 1979, the combined flow of all the seeps was about 0.32 lps.

Ten kilometers west of Carrizo Springs on Jack Hart's ranch is a large outcrop of Carrizo sandstone known as Brand Rock. Here were abundant springs (3) on Pena (Rock) Creek, which was then a "bold running stream." Water holes were deep enough to swim a horse in the 1920s, according to neighboring rancher Leroy Williams, on whose land similar springs poured out. In 1834 colonizer Charles Beales stopped here. At Brand Rock there was once a big lake teeming with fish. The rock is covered with many names, dates, and brands. These are now mostly gone, even a 1968 date fading rapidly from the very soft sandstone. Many Indian artifacts have been found here. Travelers formerly stopped here to obtain water for stock and men.

Pena Springs stopped running in the 1930s. The water holes have largely been filled with sediment. Mesquite, blackbrush, prickly pears, and a few hackberry trees now cover the area. Far downstream on Pena Creek, at the Highway 191 crossing, there is still a semi-permanent water hole with live oak trees.

Pendencia (Fight) Creek in the northwest corner of the county was also a running stream in 1867 when white settlers began to arrive. The name probably refers to the resistance offered by the Indians, who were reluctant to leave their beautiful homeland.

Rocky Springs (7) were on Jim Webb's and other ranches on Rocky Creek, 13 kilometers northwest of Carrizo Springs. According to Mrs. Eubanks, many springs formerly made Rocky Creek a running stream. Numerous settlers used the water. Mrs. Eubanks fished here often. The springs have long been dry and the water holes filled with sediment. A few willows still stand in wet spots.

Espantosa (Frightful) Lake (2) is about four kilometers east of Winter Haven. Here were huge alligators which attacked men. There are rumors of travelers being tied up by bandits and thrown into the lake to be eaten by alligators, and of buried treasure nearby. In 1836 a party traveling from the Dolores colony in Kinney County to San Patricio in Nueces County was attacked by Comanches here. Eleven whites were killed. In the same year General Santa Anna's army stopped here on its way to San Jacinto. In 1876 the Texas Rangers killed a band of desperadoes at the lake.

Espantosa Lake, in an old Nueces River channel, was fed largely by springs on Comanche Creek. The good water, shade, and abundant grass made it a welcome rest stop for many travelers. Comanche Creek was probably the *Caramanchel* referred to by many Spanish explorers. It is also sometimes spelled Caimanche, possibly for the numerous *caimans* or alligators found here. Now the lake is fed chiefly by surface runoff and waste water from Crystal City. But some seepage from El Pico sand still enters Comanche Creek. Many large live oaks yet shade the shores.

Some springs still come out along the Nueces River, chiefly as underflow through alluvial gravel. One (11) is just downstream from Boynton Dam. It is usually under water from the downstream Bookout Reservoir. It was much used during the drought years of the 1930s. Large pecan and live oak trees shade the site.

San Roque Water Hole or **Lake (8)** was eight

kilometers southeast of Catarina, on the R. W. Briggs ranch. At this valuable water source an Indian battle occurred. The lake was fed by seepage from El Pico sandstone along a fault. The lake has now been enlarged by a dam. A salt crust formed by seepage from the dam indicates that the water is slightly saline. Herons, cranes, geese, and ducks stop here among the cattails.

Nine kilometers southeast of Asherton on Val Lehmann's ranch is a large group of archeological sites. Here the El Pico sand is faulted against Bigford clay. Evidently there were once very small springs here which were used by the prehistoric inhabitants. Celestino Gonzales, who arrived in Asherton in 1904, says that he was told there were springs here prior to that time. They have long been dry.

Santa Catarina Springs or **Water Hole (9)** were apparently 13 kilometers southwest of Catarina on William Beinhorn's ranch, operated by Harvey Lansford. When Fray Juan Agustin de Morfi stopped here in 1777, he complained that the water was stagnant and that his party had to drive away the wild horses before they could use the water. Seeps probably issued from a fault in El Pico sand which crosses Catarina Creek. They have long been dry. Now there are only some hackberry trees, jaras, and brush.

San Lorenzo Water Holes (5) were in the southwest corner of the county on San Lorenzo Creek about three kilometers north of the Webb County line. On Wesley West's Faith ranch, they were the site of several Indian campsites. Later the water holes were much used by Spanish explorers, and they were on the old Presidio Road. The water seeped from Bigford sand. The holes have been dry since early in the twentieth century, but a few live oaks still survive.

San Pedro Springs (4) are nine kilometers north-northeast of the southwest corner of the county. They are on Hugh Fitzsimons' ranch, operated by Farrell Bradshaw. A historical monument adjacent indicates that the old Presidio Road passed this spot. Morfi in 1777 complained that these springs also were stagnant. This must have been a very dry year. The springs were portrayed on G. W. Colton's 1876 *New map of the state of Texas* and on Rand McNally's 1883 map, *Texas and Indian territory*. Many flint and chalcedony projectile points and worked flakes can be found here.

The fresh water of San Pedro Springs trickles from Carrizo sand on sandstone. On January 30, 1979, the discharge was 0.10 lps. The springs are reported never to have failed. Moss covers the sandstone ledges, where many names and dates have been carved. Ducks stop here, and raccoon tracks are numerous. Marsh purslane, water plantains, and cane thrive in the pools, shaded by live oaks, willows, and seep willows.

Eleven kilometers north-northeast of San Pedro Springs on the J. R. Hamilton ranch was **Charco del Cuervo (Crow Water Hole)** or **Paraje de los Cuervos (Place of the Crows) (6)**. This water hole was much used by Spanish explorers in the eighteenth century. But the crows may actually have been grackles, which are numerous in the vicinity. According to Mrs. Blanche O'Meara Eubanks of Carrizo Springs, there were good springs here, on Botella Creek, which stopped flowing in the 1950s.

DONLEY COUNTY

Most of Donley County's springs issue from the Ogallala sand and gravel, which dip gently toward the major streams and rivers. The formation, up to 230 meters thick in the northwest, was originally largely saturated with water. Usually the springs emerge from the base of the Ogallala, where it rests on less permeable Permian shales, siltstones, sandstones, and dolomite. A few very small springs occur in Permian sandstone and gypsum, but their water is usually moderately saline and unfit for drinking.

The springs have been used by humans since the days of the Paleo-Indians who hunted mammoths and saber-toothed tigers more than 10,000 years ago. In historic times bears, wolves, panthers, and jaguars haunted the springs. Ducks were so numerous they were shot for sport from the trains at Lelia Lake. Many of these animals have now disappeared, as have many plants which were associated with springs. The usual plants still found around the springs include cottonwoods, willows, some salt cedars, grapevines, plum thickets, cattails, and rushes.

Springs once burst from the valley slopes all the way up to the caprock, and often above it. The lakes were all filled with water. The situation is greatly changed now. Pumping from irrigation and municipal wells has greatly lowered the water table. From 1961 to 1967 the decline was as great as 10.9 meters. It has been estimated that in 1967 natural recharge to the aquifer amounted to about 10,000 acre-feet or 391 liters per second, only about one fourth of the volume pumped. With the falling water table, many springs have weakened and failed.

There is evidence of severe erosion in the past, in the form of partially healed gullies. The sand from these gullies has filled many stream channels and buried some springs. Many springs were also covered by Greenbelt Reservoir, constructed in 1966.

Sand-filled Luttrell Springs.

The spring water is generally of a calcium bicarbonate type, fresh, very hard, and alkaline. The content of silica and fluoride may be high.

Most of the writer's field studies were made during the period August 1-6, 1978. It should be kept in mind that springs' flows are lower than average during the summer months because of irrigation pumping and transpiration by plants.

In 1878 hunters camped at the head of Kelly Creek furnished buffalo, venison, and antelope to the residents of Clarendon. **Kelly Springs (12)** were located here, seven kilometers west-northwest of Clarendon. According to Flossie Reynolds, a long-time nearby resident, they were covered with sand and stopped flowing around 1960. A grove of cottonwoods still marks the site, on Ray Pittman's ranch.

On Forrest Sawyer's ranch eight kilometers north of Clarendon, springs (18) formerly emerged in the channel of the Salt Fork of the Red River. In 1941 they produced 1.1 liters per second. Now they are beneath Greenbelt Dam.

Dunbar Springs (19) are 12 kilometers north-northwest of Clarendon in Sherwood Shores on the north side of Greenbelt Lake. They were depicted on G. L. Gillespie's 1875 *Map of portions of Texas, New Mexico, and Indian Territory* and on his 1876 *Map of western territories.* They were popular with early Americans in prehistoric times, who had a burial ground nearby. In 1884 the headquarters of the Quarter Circle Heart ranch were located here. Old Clarendon or Saint's Roost also grew up here, because of the springs in Carrol Creek. Carrel Rippetoe, manager of the Sherwood Shores water department, guided the writer to them. On March 16, 1968, the many springs poured out 19 lps at an elevation of 820 meters. On August 5, 1978, the discharge was 13 lps. Greenbelt Reservoir depends to a large extent upon spring flow. If the springs dry up, will the reservoir still be capable of furnishing the necessary water?

On an 1882 General Land Office map of Donley County, Spring Creek was shown seven kilometers southwest of Jericho. **Nester Spring (20)** was just below the caprock on this creek, two kilometers southeast of the present Boydstun cemetery. From this spring Henry Boydstun hauled water in 1887. It is dry now, but other springs still run downstream on Spring and Allen Creeks. Cottonwoods still fringe the creek beginning about one kilometer downstream from the former spring. On August 5, 1978, there was a discharge of 2.5 lps in Allen Creek at the Roach ranch crossing. The ranch is operated by Skeet Brown.

Cottonwood Springs (13) are on Rock Creek 10 kilometers south of Alanreed. On Mrs. Corrie D'Spain's ranch, they were shown on E. H. Ruffner's 1875 *Military map of the Indian Territory.* The many flint points and tools found here indicate that this was a popular spot for thousands of years. In 1902 John Cox built one of the first dugouts in the area with a wooden floor near the springs. On March 6, 1968, the discharge was 15 lps at an elevation of 820 meters. On August 4, 1978, it was 7.5 lps, which ran three kilometers to Whitefish Creek. Many button bushes, white-flowered vauquel bushes, rushes, horsetails, and cottonwood trees fringe the pools in which minnows dart.

Seventeen kilometers northeast of Clarendon are **Glenwood Springs (14).** Located on Earl Williams' ranch, they feed Glenwood Creek. On August 4, 1978, they produced 2.1 lps which ran two kilometers before sinking in the sand-filled channel. Black soil areas on the surrounding hillsides disclose that many more springs once flowed here. Bois d'arc as well as cottonwood trees fringe the stream.

Luttrell Springs (17) are 10 kilometers north-northwest of Lelia Lake, on Leeroy Luttrell's ranch. On January 4, 1968, they poured out 14 lps from an elevation of 760 meters. On August 5, 1978, the yield had been reduced to 1.3 lps, which ran 300 meters before disappearing into the sand-choked channel. Much irrigation pumping is done nearby. The springs are surrounded by rushes, water cress, and purple-flowered ironweed, shaded by willows and grapevines.

Chamberlain Springs (15) are one kilometer farther east in a similar bluff on the south side of the Salt Fork Red River. Will Chamberlain has found Clovis and other projectile points here, which signify that this has been a popular living site for many thousands of years. On January 4, 1968, the discharge was 13 lps. On August 4, 1978, it was down to 1.6, due largely to irrigation pumping nearby. Minnows, frogs, and wild turkeys frequent the springs, where water milfoil,

rushes, ironweed, and grapevines grow.

Eagle Springs (16) are nine kilometers north-northeast of Lelia Lake. On Clovis McCary's ranch, they formerly fed Eagle Arroyo. On February 27, 1966, they produced 11 lps. As recently as 1968, according to McCary, a large swamp surrounded them. Now the springs have been excavated to form a pool of live water, but there is no overflow. Five irrigation wells have been drilled to the south since 1968. Sand has covered many of the springs and buried a fence near the road. Llamas, ostriches, aoudads, and other exotic animals are now raised here. Other similar springs may be found nearby.

Naylor Springs (6) are 10 kilometers north-northwest of Hedley. On Thomas Naylor, Jr's property, they are just west of Lelia Lake Creek. Here the senior Thomas Naylor built a cabin in 1889. A post office was located here, and the postal route through the area is still called the Naylor route. A cottonwood switch planted at the springs by Mr. Naylor grew into a tree, which is yet there. Many camp meetings were held at the springs. Numerous area residents came here for water, as many of their springs and wells contained much gypsum. As recently as 1939 Roy Brown of Hedley hauled water from these springs. Many seeps from the base of a bluff form a swamp where snow-on-the-mountain flowers as well as the usual water-loving plants grow. According to Thomas Naylor, Jr, the flow formerly filled a 2-inch pipe, representing possibly 1.3 lps. In 1978 it was 0.075 lps. A barrel, formerly sunk in the springs, has now been buried in sand.

Around Lelia Lake were formerly a number of lakes on West Lelia Lake Creek which were loaded with waterfowl. In the 1890s many people came by train for picnics and camp-outs here. The lakes, which were fed by springs (1), began to dry up in the late 1950s, according to R. B. Sain and Mrs. Louis Drumm, nearby residents. Now they are usually dry, except after heavy rains. A few seeps still exist on Coleman Shields' farm. Much irrigation pumping is done in the vicinity. Ducks, beavers, and frogs still live among the rushes, but their future in this drying environment is not bright.

The springs (2) on East Lelia Lake Creek, three kilometers southeast of Lelia Lake, still flow. On August 2, 1978, there was a discharge of 1.6 lps at Highway 287. Seven kilometers downstream the flow increased to 2.2 lps. Still farther downstream, near Naylor Springs, it decreased to 1.0 lps. Minnows play in the cottonwood-shaded creek.

In 1886, when the town of Giles was laid out, eight kilometers southeast of Hedley, numerous fresh-water springs including **Buck Spring (4)** just east of the town fed Buck Creek. Fishing, wading, and baptizing were popular in the creek. Many rabbit roasts and fish fries were held on its banks, according to author Virginia Browder. For a time there was a treasure hunt here for jars of gold and silver coins believed to have been buried by Mrs. Mevis near the Giles general store. In 1943 Buck Spring still produced 0.32 lps. But according to owner Mrs. A. E. Ranson, Buck Creek has not flowed, except during storms, since at least 1938.

Parker Springs (3), two kilometers south of Giles, feed Parker Creek. In the late 1800s these springs were used by the stock shipping pens, now owned by Vera Dickey. The Shoe Bar, Diamond Tail, and other ranches brought their cattle here for shipment on the railroad. In 1932 the springs trickled 0.32 lps, but are now only seeps in standing pools.

Just to the south are some similar, smaller springs called the **Highway Springs**. They were in a former roadside park on Highway 287, now unused, but still containing stone picnic tables. In 1943 0.13 lps emerged here. Now they are only seeps, primarily in winter. They are on Jess Bridges' property.

Browder Springs (7) are 10 kilometers northwest of Memphis on Virginia Browder's Cedar Hills ranch. According to Frank Foxhall, manager of the Donley County Water Control and Improvement District No. 1, the city of Memphis used these springs as a water supply from 1908 to 1962, when they were replaced by wells. At one time 33 bricked-up springs were in use. On January 5, 1968, the springs still poured out 12 lps from an elevation of 725 meters. On August 3, 1978, there was only 0.09 lps, partly from a pipe. In a very hilly area, the springs are surrounded by the usual vegetation plus hackberry trees and white-flowered vauquel bushes. Turkeys prowl the area. Gray soils signify that a large swamp once existed here, fed by many springs.

Ten kilometers south of Hedley were **Broome Springs (5)** on Indian Creek. The water issued from Permian Cloud Chief gypsum and contained 3,000 milligrams per liter of sulfate, making it unfit for human consumption. In 1943 the discharge varied from 0.95 to 1.6 lps. Now there are only pools of standing water on Mrs. Sim Reeves' ranch.

Indian Springs (8) are eight kilometers southwest of Hedley on Earl Wheatly's Indian Creek ranch. Four bricked-up springs supply water to the headquarters buildings and corrals. The excess runs into a rush-filled swamp. On May 24, 1943, the discharge was 0.82 lps. On May 21, 1949, and August 3, 1978, it was 0.20 lps.

According to Wheatly, the springs in this vicinity have been gradually drying up since 1958. Indian Creek dried up at the ranch during the summers of 1976 through 1978 for the first time.

Bitter Creek Springs (9) feed Bitter Creek on the East Bitter Creek ranch 12 kilometers south of Lelia Lake. The ranch, owned by L. R. Hagy, is managed by Jerrel Martin. The spring water, from Ogallala sand, is quite fresh, as shown in the table of Selected Chemical Analyses. Probably Bitter Creek got its name from more saline springs in the Permian formations downstream. On March 5, 1968, the discharge was 50 lps. On August 3, 1978, it was 3.7 lps, including an estimated 1.6 lps of evaporation from several lakes and a swimming pool. The stream contains much water cress, duckweed, water parsnips, and marsh purslane. A large former swamp here is marked by dark gray soils, partially buried under modern sediment and then dissected by gullies. According to Martin, the flow of these springs is declining because of irrigation pumping.

West Bitter Creek Springs (10) are 14 kilometers south-southeast of Clarendon. The West Bitter Creek ranch is managed by Horace McClellan. On December 19, 1967, they poured out 10 lps. On August 3, 1978, the yield had decreased to 0.52 lps. Much gully erosion has choked the stream channels here with sand. Irrigation wells pump nearby. Frogs still play in pools containing water milfoil.

Ten kilometers south-southwest of Clarendon were **Sandy Springs (11)** at the J. A. ranch's Sandy Camp. Owned by Montie Ritchie, the ranch is leased by Vera Lewis. The springs were once the source of Big Sandy Creek, producing 3.8 lps on March 19, 1968. Now they are quite dry and buried under sand. Irrigation wells pump nearby. The site is in a jungle of hackberry trees and grapevines, with one huge cottonwood. Wild turkeys and hawks still live here.

In the Mulberry Creek drainage area in the southwest part of the county a few very small springs trickle. These are confined to the higher areas where the Ogallala sand crops out. At lower levels only the impervious Permian red beds are found.

DUVAL COUNTY

Duval County's springs flow or did flow chiefly from Miocene, Pliocene, and Quaternary sands. These formations dip toward the east-southeast at 5 to 15 meters per kilometer. Groundwater can move through the sands at three to five meters per day. In the northwest part of the county, near the Bordas Escarpment, numerous faults complicate the movement of groundwater and often control the location of springs. Salt domes have also altered the subsurface structure and influenced the formation of springs.

The springs were usually based upon perched water tables. The main water table is often hundreds of meters below the surface. Many ranchers are obliged to haul water considerable distances because of the scarcity of groundwater. That there have never been abundant springs is evidenced by names such as *Agua Poquita* (Very Little Water) which appeared on old maps.

Nevertheless there were originally more and larger springs than at present. Flowing wells, some of which still flow in the southern part of the county, did much to dry up the springs. Pumping wells and overgrazing also contributed to the damage. Water tables have declined considerably in recent years.

The springs once supported an abundant ecosystem of interdependent plants, fish, amphibians, reptiles, crustaceans, insects, birds, and mammals. As they dried up, most of these plants and animals disappeared.

The water is generally of a sodium bicarbonate or chloride type, slightly saline, very hard, and alkaline. The content of silica is usually high.

Most of the writer's field studies were made during the period February 21-26, 1979.

Eighteen kilometers south of Freer on *Las Animas* (The Spirits) Creek there were once seep-fed pools of water (8). The water issued from faulted Oakville sandstone in a rather hilly area on Mrs. L. J. Brennan's ranch. Thousands of projectile points have been found here. The water must have been very important to the prehistoric people who lived here. Las Animas ranch was established late in the eighteenth century, according to Mrs. Brennan. In the 1870s a stage stop existed here. The old building used by the stagecoaches is still in use. Now there are water holes only after surface runoff. Hackberry, elm, and frijolillo trees shade the site.

Government Wells (6) are six kilometers north-northwest of Freer on Woodrow Wiederkehr's ranch. There were probably seeps in the creek beds here at one time from faulted Catahoula sandstone. Many Indian sites have been found in the vicinity. The wells were dug 14 meters deep by the army to provide a more dependable water source. In the late 1800s this became a well-known water stop for travelers. On February 24, 1979, the water stood in pools in the creek two meters below the surrounding ground surface. A grove of live oaks carrying much ball moss, and sand-bar willows, still stands here. Many oil and gas wells pump nearby.

Charco Valiente (Strong Water Hole) (5) was in northern Duval County at latitude 28°01' and longitude 98°34'. On James Foster's ranch, there were pools of live water here in San Jose Creek seeping from Miocene Catahoula tuff. In 1766 Marquis Cayetano Maria Rubi probably paused here on his return from an inspection of Spanish presidios and missions in the province of Texas. The charco was shown on an 1863 General Land Office county map. Since about 1904, according to Doris Foster, there have been only occasional pools of surface runoff. On February 24, 1979, some pools were present. Sand-bar willows and water plantains thrive here. An oil and gas field surrounds the site.

Charco de Anagua (Water Hole of the Waterless Area) (4) was nine kilometers east-southeast of Charco Valiente, on Charles Dodd's ranch. It was formerly fed by seeps from Oakville sandstone. It must have been an important water stop in 1863, when it was depicted on a county map. Now it holds water only temporarily after surface runoff. Many wells pump nearby. Huisache, frijolillo, and one live oak tree adorn the site. Deer, quail, and javelina are hunted here.

In San Diego Creek just south of San Diego are **Casa Blanca (White House) Springs (1)**, the only springs which still flow in the county. On February 23, 1979, numerous seeps from Lissie caliche and gravel in the creek bed at an elevation of about 85 meters produced 1.3 liters per second. The seeps of slightly saline water start at the railroad bridge west of town. There is evidence that many springs once flowed from the adjacent slopes. On the south side of the creek in 1852 stood the Casa Blanca trading post and fort. The old building is still in use as a bar by Carlos Saenz. In the pools are numerous cattails, water plantains, water hyacinths, water shields, and algae. Minnows, frogs, crawfish, and killdeers reside here. Hackberry and chinaberry trees provide shade.

Along Tarancahuas Creek upstream from Rosita were formerly many seep-fed water holes (7). The creek was named for the Indians who once lived here. The water holes were used by the settlers at Rosita around 1860, who also were able to obtain water from very shallow wells. Long-time resident Narciso Valerio remembers large charcos here in 1914. By the 1930s they had dried up. The water seeped from faulted Goliad and Fleming sands. Live oak, elm, and hackberry trees still fringe the creek.

La Mota de Olmos (The Elm Grove) (10) was an early settlement six kilometers east of Benavides, now on Roman Escobar's ranch. Here seeps from Goliad sand fed water holes. The creek's name, Piedras Pintas or Painted Rocks, suggests that Indians once lived in the vicinity. The holes are now dry except during storms. Several wells pump nearby.

Seventeen kilometers southeast of Benavides was Laguna Travesada (Crossing Lake) (9). Shown on an 1875 county map, it was fed by seepage from Lissie sand and was an important water source to early settlers. It is now on Hilario Elizondo's ranch. When Anselmo Vera, a nearby rancher, hunted here in 1945, the lake covered 14 hectares. Now it is filled with modern sediment and dry. On February 26, 1979, the old lake bed was covered with grass and other green plants, beneath huisache, mesquite, and hackberry trees which had not yet leafed out. Nearby is another former lake called Sal si Puedas (Get Out if You Can). This lake bed becomes very soft after runoff collects in it.

On Concepcion Creek east of Concepcion there were formerly seeps (2) from windblown Quaternary sand. Several Indian sites have been found here. Perhaps these people dug shallow wells to make their water supply more reliable. According to long-time resident Jose Lozano, the creek has been dry except for storm runoff since the turn of the century. Now there are only elm and hackberry trees, yellow buttercups, and the usual brush. Some live oak trees still survive at the old Salas community three kilometers north of Concepcion on Los Olmos Creek.

Ten kilometers southeast of Concepcion is a caliche pit (3) on Wayne Pettit's ranch. It holds slightly saline water derived from Quaternary sand, maintaining a water level about six meters below the surrounding surface in 1979. Minnows, ducks, doves, and killdeers live among the cattails.

Twelve kilometers north-northwest of Hebbronville are some water holes (11) on Alonzo Benavides' ranch. Fed by groundwater from Goliad sand, they are located at the junction of Mesquite Creek and Arroyo de los Angeles. According to Gilbert Gonzales of Benavides, the water was used by stagecoaches which stopped here en route from San Antonio to Rio Grande City. Some live oaks still shade the pools.

Thirteen kilometers southwest of Benavides on the Bannworth ranch were **Guajillo Springs** and tank (12). The springs, which issued from Goliad sand, were shown still to be active on a 1967 Geological Survey topographic map. On February 26, 1979, however, the springs and tank were very dry. They took their name from the *Guajillo* or catclaw acacia which is abundant here.

ECTOR COUNTY

Crossing the southwestern part of Ector County from northwest to southeast is the Concho Bluff, an escarpment which slopes to the southwest. Here the Lower Cretaceous Fredericksburg limestone and Antlers sandstone are exposed. Good springs once flowed from these formations. Small springs and seeps from Quaternary sand fed Monahans Draw and some of the larger lakes. All have been dry for many years.

Paleo-Indians roamed the area many thousands of years ago, camping at the springs. Perhaps these people were already here some 40,000 years ago when the huge Odessa meteorite crashed to earth. In the seventeenth century Spanish explorers began entering the county, probably guided by Indians over old trails to the better springs.

Water levels have declined greatly in the county, due chiefly to pumping of groundwater for municipal, industrial, and oil-field uses. From 1948 to 1969, declines of as much as 20 meters were measured. As there is little rainfall in this area, recharge of the aquifers is only a small fraction of the discharge of groundwater. As a result the small springs disappeared early.

A complex ecosystem of plants and animals once depended upon the springs and spring-fed streams and lakes. Willow and cottonwood trees, cattails, and bulrushes, ferns, milfoil, and water cress thrived in the spring waters. Fish, frogs, turtles, snakes, lizards, crawfish, and aquatic insects made the springs their home, as well as many larger animals which preyed upon them. Ducks, geese, herons, cranes, and other waterfowl found refuge on the lakes, usually brimful. When the springs, streams, and lakes dried up, most of these plants and animals vanished.

The spring waters were normally of a calcium or magnesium bicarbonate type, fresh to slightly saline, very hard, and alkaline. The content of silica and fluoride was usually high. The chemical analysis of water from well 139 shown in the table of Selected Chemical Analyses is fairly typical of the type of water which once flowed from the county's springs. The water level in this well, nine kilometers west of Odessa, was 7.3 meters below the surface in 1937 when the analysis was made. Much of the groundwater has now been contaminated by oil-field brines and industrial wastes formerly placed in unlined surface pits, and by inadequately cased or cemented oil wells.

Most of the writer's field studies were made during the period November 26-31, 1978.

Bum Lake is on Highway 181 on Buster Cole's ranch, 13 kilometers northwest of Goldsmith. Here Teddy Stickney, noted Midland archeologist, has found much pottery, burned rock, and worked flint fragments. This was evidently a living area for a prehistoric people. Very small springs (4) from Quaternary sand and caliche probably kept the lake full of water and fish at that time. Now the lake bed is dry pasture surrounded by oil wells.

In 1850 Captain Randolph Marcy, exploring for a road to the west, passed through the county. He wrote:

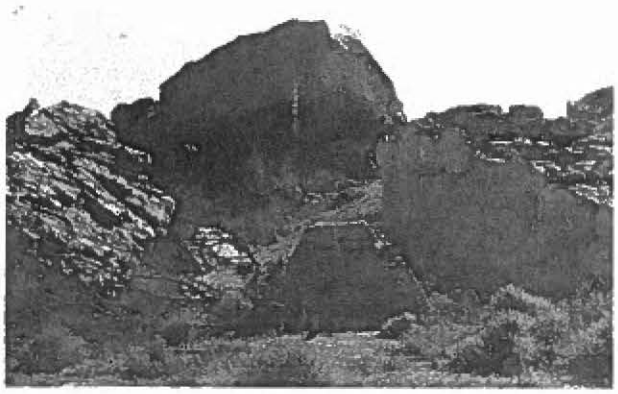
> We are near two ponds in the prairie, where, judging from present appearance, there will always be water found, except in the dryest season; the grass is good. Our coursé from the sand hills is N. 57°E., and the distance fifteen miles and three-tenths.

The ponds he described are probably Plover and Prairie Dog Lakes, about one kilometer apart, on Arthur Wight's ranch eight kilometers east-southeast of Goldsmith. Mr. Wight has found much burned rock and flint flakes nearby. Evidently these lakes were a popular camping site long before Marcy arrived. Seeps (5) from Quaternary sand and caliche once kept the lakes full. Now both are in pasture, dry except for occasional surface runoff. Many oil wells pump nearby.

Bessye Cowden Ward's ranch is on Monahans Draw just south of Odessa. There evidently were seeps (1) along the draw in the past. Paleo-Indians frequented this vicinity, according to Teddy Stickney. Probably there was still some seepage when Mexican shepherds arrived around 1880. Now only storm runoff and sewage flows in Monahans Draw. A few scattered elms, chinaberry trees, mesquites, salt cedars, and yucca shade the draw. Prairie dogs are still numerous, apparently not suffering from the lack of water. Jackrabbits have about disappeared, according to Mrs. Ward, leaving nothing for her dogs to chase.

At the Pleasant Farms community in southeast Ector County is Vernon Blain's K-Bar ranch. Here Landreth Draw has cut a ravine in Concho Bluff. Many burned-rock middens have been found here by Mrs. A. D. Clayburn. This was obviously a favored campsite in prehistoric times. Very small springs (2) evidently trickled from Fredericksburg limestone. Now a windmill pumps near a dry swimming pool, shaded by a few poplar trees. Creosote bush and mesquite cover the surrounding hills.

Henderson Springs (3) were five kilometers south-southeast of Notrees on Sonny Henderson's ranch. Here very small springs and seeps formerly issued from massive Antlers sandstone in a ravine on



Rock shelter at Henderson Springs.

Concho Bluff. A prehistoric people lived in shelters under the large boulders. Pictographs, now mostly destroyed, formerly decorated the walls. Many flint points and tools have been found here. Bedrock mortar holes are present. Some of the boulders have been crown-polished or worn smooth by the rubbing of hides on them to remove fat or hair. An earth tank occupies the former springs site. Many oil wells pump nearby. Creosote bush, mesquite, and catclaw cover the surrounding hills.

EDWARDS COUNTY

Nearly all of the springs in Edwards County flow from the cavernous and vugular Edwards and Associated limestones. In this area they are known as the Segovia, Fort Terrett, Devils River, and Salmon Peak limestones, but they are essentially the same as the Edwards and Associated limestones along the Balcones fault zone farther east. These formations dip to the south at about 2 meters per kilometer. The springs issue in deep, rugged canyons, chiefly in the eastern part of the county. In the lower parts of these canyons the Glen Rose limestone is exposed, but practically all of the spring flow issues from the Edwards limestones above.

The annual recharge to and discharge from the aquifer in the county was estimated to be about 0.18 cubic kilometer or the equivalent of 3.3 centimeters of rainfall in 1962. As wells pump less than 1 per cent of the discharge and springs discharge the remainder, one might suppose that spring flow could not have been seriously affected by man's activities. This, however, is not the case. Disastrous overgrazing and cutting of timber have removed most of the thick organic mulch which once covered the hills and assisted recharge of water into the underground reservoir. As a result, recharge has been considerably reduced and many of the smaller springs have dried up. In addition, as a greater proportion of the water now runs off, floods have become more serious. Huge quantities of gravel and cobbles have been washed into the stream channels, burying some springs. But springs are still very numerous in the county, and only the more important are mentioned here.

All of the larger streams disappear into gravel and cobbles and reappear at frequent intervals as springs. This phenomenon is called stream or river "underflow."

For many thousands of years the Tonkawas and Lipans lived at these springs, leaving paintings in rock shelters and many artifacts. In historic times the Kickapoos, forced out of their homes in the east, resided briefly at the springs before being evicted from this area also.

At the springs plants such as water cress, marsh purslane, water shields, milfoil, and water lilies thrive. In the immediate vicinity are usually found large live oaks and cedars, sycamore and chinaberry trees, and algerita and seep willow shrubs. The hillsides have been badly abused by clear-cutting of timber and overgrazing by sheep and goats. As a result, some of the native plants such as Mexican fern, purple cliffbrake, and cedar sedge are now hard to find.

In the waters live crawfish, fish, frogs, snakes, mussels, snails, and various insects. Feeding upon these smaller animals are ducks, herons, killdeers, raccoons, bobcats, gray foxes, coyotes, and an occasional mountain lion. Herbivorous animals which frequent the springs include several kinds of deer, turkeys, beavers, nutrias, porcupines, and javelinas.

The water is generally of a calcium bicarbonate type, fresh, very hard, and alkaline. The use of oil-field brine on highways to melt ice is expected to contaminate spring waters in time.

Most of the writer's field studies were made during the period December 31, 1978 to January 5, 1979.

Rock Springs (1), for which the town of Rocksprings was named, are in a county park on the north side of the town. When W. J. Greer established a sheep camp here in 1882, the springs spouted a 2½-centimeter stream of water. Rattlesnakes were so numerous that cowboys could not sleep near the springs. Outlaws later camped here, and in 1891 the Rocksprings post office was at the springs. On March 9, 1939, the flow was 0.06 liter per second. On December 31, 1978, there was only a seep from Buda limestone onto a wide outcrop of flat rock. On June 28, 1979, the springs were quite dry. Numerous wells in Rocksprings have drained away the groundwater. A historical marker regarding the springs is nearby.

Twenty-five kilometers southwest of Rocksprings, at latitude 29°55' and longitude 100°26', are **Silman Springs (7)**. On Sam Epperson's ranch, they produced 0.06 liter per second on September 23, 1954, and about 0.05 on January 1, 1979.

Three kilometers north of Silman Springs were the very small **Justice Springs (11)**. On Fred Speck's property, they are reported to be dry now.

Five kilometers southwest of Silman Springs are **Cedar Springs (12)**. On Anita Driver's ranch, they still produce a very small stream. Cedar and Justice Springs were shown on an 1892 U. S. Geological Survey topographic map.

Paint Rock Springs (3) are 15 kilometers southwest of Telegraph on Frank Guthrie's ranch. In 1842 Big Foot Wallace killed an Indian here. From 1852 to 1883 the springs were a midway stop on the Fort Clark-Fort McKavett road. In 1877 Major John Jones assembled a frontier battalion here to begin a roundup of outlaws in the area. W. R. Livermore's 1883 *Military map of the Rio Grande frontier* portrayed the springs. According to Guthrie, they were much larger around the turn of the century when they formed the head of the South Llano River. On January 1, 1979, 0.30 lps flowed into a water hole adjacent to a high limestone bluff. This discharge all disappeared before reaching a rock crossing one kilometer downstream. A historical marker commemorates the site.

Now **Llano Springs (4)**, four kilometers downstream, form the headwaters of the South Llano River. They are on Fay Rodman's ranch, operated by Ed Howell, 11 kilometers southwest of Telegraph. They break forth from cobbles and gravel on Edwards limestone below a bluff and rest area on Highway 377. The water has been used for irrigation. On February 10, 1939, the discharge was 4.4 lps. During the 1950s the springs nearly dried up. On January 1, 1979, after rains, 22 lps gushed out. On this date much steam rose from the springs at an air temperature of 2°C. Minnows and water striders play among the water cress. (See Plate 16, d).

Deats Springs (5) are nine kilometers south-southwest of Telegraph on Mrs. Temple Deats' ranch. Here around 1880 a Mr. Baldwin built a dugout, according to Mrs. Deats. On January 5, 1939, the discharge was 12 lps. From 1952 to 1955 the springs were dry. On January 1, 1979, the chain of springs at the base of the limestone bluff on the South Llano River produced 22 lps. A hydraulic ram once pumped the spring water. Nearby are some mortar holes in the bedrock, left by a people who lived here long ago.

Bluff Springs (6), also on the Deats ranch, are two kilometers east of Deats Springs. Several springs here cascade from limestone bluffs draped with maidenhair ferns to form the source of Bluff Creek. On February 16, 1956, and January 1, 1979, the discharge was about 6.3 lps, but the flow nearly dried up in the 1950s. At the high bluffs at the mouth of the creek was once a large turkey roost, and later a Boy Scout camp.

Eight kilometers south-southwest of Telegraph on Ennis Jetton's ranch are **Tanner Springs (10)**. They formerly powered a mill, developing 16 horsepower. The old millstone still lies at the ranch house. The water has also been used for irrigation. Many worked flint fragments litter the vicinity. The discharge from the base of a bluff of Edwards limestone at an elevation of 577 meters was 250 lps on February 11, 1929, 260 on February 22, 1939, and 250 on January 1, 1979. In cold weather much steam rises from the springs. Beavers work nearby. In a pecan grove 300 meters southeast on the bank of the South Llano River is a smaller group of springs.

Seven Hundred Springs (9) are seven kilometers south of Telegraph on Joe Schero's ranch, managed by C. S. Adams. They burst from numerous cavities in Edwards limestones at the base of a bluff on the northwest side of the South Llano River at an elevation of about 500 meters. They form a lake 800 meters long containing much water milfoil, pondweed, and fish. Maidenhair ferns and water cress cover the rocks around the springs. The number of openings from which water flows varies, being larger at higher discharges. Pecan, sycamore, and live oak trees and grapevines shade the area.

Some of the projectile points and knives left by prehistoric residents have been mounted in concrete gate posts at the ranch entrance. In 1880 Middleton Bradford and his family settled here, carrying water from the springs. They have been used for crop irrigation. Discharge records in lps by water years follows:

1939	410	1968	420
1952	310	1969	420
1956	310	1970	570
1959	790	1971	510
1961	710	1972	590
1962	620	1973	910
1963	450	1974	510
1964	450	1975	710
1965	450	1976	650
1966	420	1977	650
1967	480	1978	510

The average annual discharge has been 460 lps.

Big Paint Springs (8), also large, are seven kilometers south-southeast of Telegraph on Mrs. Ruth McLain Bowers' ranch. In 1542 or 1543 Andres do Campo of Coronado's army and two Indian *donados*

or lay brothers may have camped here on their return to Mexico from *Quivira* in present Kansas. More recently, the water has been used for irrigation. In 1938 the springs supplied four fish ponds. On March 8, 1939, 620 lps gushed from several crevices in Edwards limestone. On September 1, 1955, the discharge was 510 lps, and on March 26, 1962, it was 880.

Eleven kilometers northeast of Rocksprings is the **Devils Sink Hole (41)** on C. V. Whitworth's ranch. In 1939 there was a stream of water seven meters wide which flowed slowly from northwest to southeast across the bottom of the sinkhole, about 100 meters below the surrounding surface. Now, according to Whitworth, there are only pools of live, fresh water, called Emerald Lakes, but no discernible flow. Dripping springs line the sides of the sinkhole. In 1880 water was taken from the sinkhole on cattle drives. In 1885 a windmill was installed to pump the water. In 1889 H. S. Barber carved his name at the bottom of the entrance. At various times guano has been mined here. Two people are known to have lost their lives in the cave.

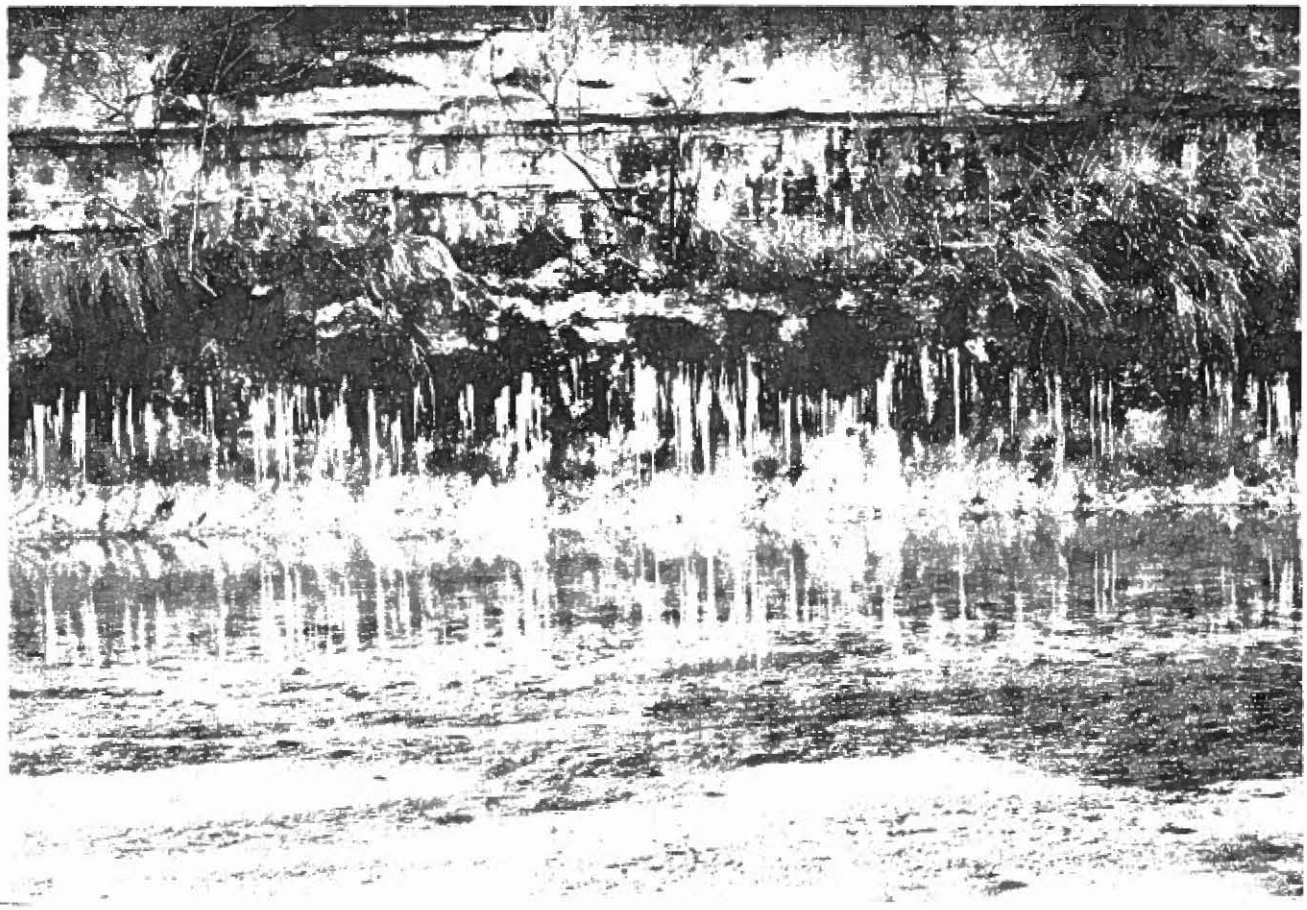
In early days a wagon load of honey was shot down from the sinkhole walls. In 1934 blind fish were found in the lakes, but have not been seen since (Kennard and others, 1975). Devils Sink Hole contains a colony of several million Mexican free-tail bats. Cave swallows also inhabit the walls. Four troglobite (cave-adapted) species, all eyeless and depigmented, live here: a spider, a milliped, an amphipod, and an isopod. The amphipod is found only in Devils Sink Hole. Several burned-rock middens and Indian artifacts are nearby.

Hackberry Springs (17) are 14 kilometers east of Rocksprings on Claud Gilmer's ranch. Pouring out at an elevation of 600 meters, the waters feed a pond containing water shields and form the head of Hackberry Creek. A. W. Spaight's 1882 *Official map of the state of Texas* and the New York and Texas Land Company's *Map of the state of Texas* depicted the springs. On February 9, 1939, the discharge was 72 lps. On October 7, 1954, it was 180 lps, and on January 2, 1979, it ws 71.

Benskin Springs (13), also on the Gilmer ranch, are two kilometers southeast of Hackberry Springs. The fresh water issues close to Highway 335 and flows to Hackberry Creek. On January 6, 1939, the discharge was 6.2 lps. On January 2, 1979, it was 1.6. The flow fluctuates considerably with the seasons.

Lane Springs (33) are two kilometers east of Benskin Springs on Sidney Hyde's ranch. Located in Lane Draw, the springs produce fresh water. Many flint projectile points have been found in this vicinity. On February 8, 1939, 12 lps gushed from cavities in limestone and flowed to Hackberry Creek. On January 3, 1979, 1.9 lps emerged, running only 200 meters and not reaching Hackberry Creek.

Icicles produced by seeps along Hackberry Creek.



Cade Springs (56) are just east of Highway 335 at latitude 30°00'. The issue from near the base of the Edwards limestones and flow over flat rocks to Hackberry Creek. Two burned-rock middens are just south of the springs. Minnows dart among the pondweed. Seep willows shade the pools, which are edged with pink travertine. The discharge was 5.1 lps on January 17, 1939 and 10 on August 16, 1955, and January 3, 1979. **Willow Spring** is four kilometers southwest in Cade Hollow.

Thurman Springs (34) are just east of Hackberry Creek at latitude 29°59'. They are on Mrs. Neil Schoolfield's ranch, leased by Milton Jones. On February 22, 1939, and January 3, 1979, the discharge from near the base of the Edwards limestones was 0.95 lps. The water flows through water cress for about 300 meters before disappearing. The old stone chimney of an early ranch house stands nearby.

Two kilometers farther southeast are **Kemp Springs (35)**, also on the Schoolfield ranch, in Kemp Draw. On February 22, 1939, they produced 1.1 lps. On January 3, 1979, the discharge was 0.55 lps, which flowed 100 meters, forming travertine deposits.

Three kilometers farther downstream are **Hawker Springs (36)** on the east side of Hackberry Creek. On February 22, 1939, the flow was 1.4 lps. On January 3, 1979, it was 1.3, flowing to Hackberry Creek. Spotted axis deer may be seen here.

On Highway 335 at latitude 29°56' are some freshwater springs (37) on Adele Frost's ranch. On February 23, 1939, they discharged 3.1 lps, on August 16, 1955 they produced 25 lps, and on January 3, 1979 — 1.4 lps, which flow to Hackberry Creek amid water cress.

Two other springs, No. 39 and 40, are three and five kilometers respectively southwest of those on the Frost ranch. They are on Mrs. Scott Collins' ranch, managed by A. J. Cox. No. 39, in Ruth Draw, poured out 3.1 lps on July 21, 1955, but has now been buried under gravel. No. 40 produced 6.3 lps on the same date and is reported still to be flowing well.

McCurdy Springs (20) are 20 kilometers north of Barksdale on the west side of the Nueces River valley. On Gene Borchardt's ranch, they are now beneath a large Lake. They have been used for irrigation. On March 17, 1924, the discharge was 310 lps, on February 27, 1939, it was 100 lps, and on August 16, 1955, after heavy rains, 410 lps. Herons, ducks, and nutrias inhabit the fresh water.

Polecat Springs (42) are 17 kilometers south-southeast of Rocksprings on Howard Cottle's ranch. At the head of Polecat Creek, they furnish water for a large herd of goats. A burned-rock midden adjacent testifies to the long prehistoric use of the springs. An 1891 U. S. Geological Survey topographic map portrayed the springs. On January 18, 1939, the flow was 1.6 lps. On January 4, 1979, there was only a pool of live water containing water milfoil in an excavation in the cobblestones.

Two and one-half kilometers downstream on Polecat Creek are two groups of medium-size springs (44 and 45) on George McAlister's Puerta Grande ranch, operated by David Flach. Both issue from cavernous Edwards limestone at the foot of a high bluff. Burned-rock Indian middens occur nearby on the point between Polecat and Pulliam Creeks. The lower springs (45) are about 100 meters downstream from the upper group (44). Discharge records in lps are:

	Upper Springs	Lower Springs
January 18, 1939	26	31
October 16, 1953	22	
February, 1956		13
January 4, 1979	18	13

The fresh water, containing 180 to 201 milligrams of dissolved solids per liter, has been used for irrigation. Moss and ferns adorn the rocks surrounding the springs. The water feeds several ponds, including a swimming pool with picnic tables adjacent. The small **Broomfield Spring** is five kilometers northeast, and **Greenhouse Spring** is five kilometers east-southeast.

Pulliam Springs (19), also on the McAlister ranch, are just above the mouth of Polecat Creek on Pulliam Creek, 17 kilometers north-northwest of Barksdale. The fresh water supplies several reservoirs and is used for irrigation. On January 18, 1939, 11 lps gushed out, on October 15, 1953 — 9.8, in February, 1956 — 28, and on January 4, 1979 — 9.5.

Paint Bluff Springs (55) are 15 kilometers northwest of Barksdale on Edmund James' ranch, leased by Arthur Beck. Allan Stovall's 1959 description of this spot is worth repeating here:

> One of the beauty spots of the Nueces Canyon, and a place of interest for many people over a wide area, is the painted bluff on the old Dan Roberts ranch on Cedar Creek. The high bluff on which the picture writing is located is some two miles above the Dan Roberts house. The trail that connects the two places passes close by a large hole of deep blue water. Just above the waterhole is a series of strong springs, from which gush sparkling streams of clear cold water. The supply of water from these springs is unfailing. Masses of ferns and other water plants line the river banks for some distance, and just above the springs the trail runs under an overhanging bluff, from which seep-springs send forth a constant drip of water. Farther on up the river bed, one can see in the distance the towering

> precipice known as "Painted Bluff." The face of the cliff is a beautiful sight to behold. Rising almost perpendicularly from the river's bed, the bluff rears its majestic head more than 300 feet into the sky. In the stratified face of the cliff is written the story of the ages. Eons of time have passed since the first ripple of water carried its tiny load of eroded material across the spot, and endless ages thereafter contributed to the slow carving of the deep canyon that is now Painted Bluff Canyon. Underneath, and near the upper end of the bluff, may be seen the colorful picture writing of the Indian tribes of days gone by. Some archeologists believe that the spot was a sort of post office through which the Indians communicated with one another. No one has yet been able to decipher the hieroglyphic lettering that the Indians used, but without a doubt the pictures on the cliff do have a meaning, and for one to discover a code by which the meaning can be brought to light might reveal some interesting facts concerning the life of the Indians who roamed the Canyon country before the coming of the white man.

The fresh water of Paint Bluff Springs, which issues from faults in the Edwards limestone, has been used for irrigation. The Indian paintings are now mostly gone, chipped off for souvenirs. On January 23, 1939, the discharge was 63 lps, and on January 4, 1979, it was 48 lps.

Two kilometers northeast of Paint Bluff Springs are **Roberts Springs (18)**. In Stovall's words,

> Another beautiful place in the vicinity of the Roberts Ranch is the **Crider Blue Hole**, on another prong of the river above the Roberts place. A deep round hole has been carved there out of the river bed by the constant flow of a stream of water that tumbles in a never-ending torrent from a low bluff overhead. The hole may be thirty feet deep at its deepest part, and the water is so clear that one can see the small pebbles that cover the bottom of the basin. The pool is oval-shaped, almost round, and is some forty feet across. The springs that pour their water into the little lake come from under a cliffside several hundred yards above the fall.

These springs also flow from a fault in the lower Edwards limestones. The fresh water has been used for irrigation. On January 20, 1939, the discharge was 95 lps, on October 15, 1953 — 61, and on January 4, 1979 — 70.

Taylor Springs (46) are two kilometers south-southeast of Paint Bluff Springs. They supply fresh water to the Arthur Beck house (formerly the Taylor house). They also irrigate seven hectares of cropland. On the adjacent Half-Moon Prairie is a cemetery where three members of the Coalson family, killed by Indians, were buried. Discharge records in lps include:

Jan. 23, 1939	26	Jan. 4, 1979	25
Oct. 15, 1953	27		

On the southwest side of Barksdale on Thomas Jones' property are **Barksdale Springs (50)**. They appear to be underflow springs. The water issues from alluvial gravel which is probably recharged by the Nueces River to the east. In the past, according to Terry Hill and Nina Jones of Barksdale, the springs flowed at higher elevations, from terrace gravel. The Camp Dixie ranger station was located here in the 1870s. In 1879 Sam and Mary Raney built a log cabin at the site. Early Barksdale residents hauled water from the springs until the 1890s, when a well was drilled. Terry Hill hauled water from the springs in 1895, and remembers many bass and cottonmouths in the water. On January 5, 1979, the discharge was 18 lps.

North Spring Creek Springs (47) are 11 kilometers west of Barksdale on Lester Phillips' ranch. Many Indian artifacts and burned-rock middens have been found in the vicinity. The water supplies several ranches and runs to Pulliam Creek. On February 2, 1939, the discharge was 25 lps and on January 4, 1979, it was 21.

Nine kilometers west of Camp Wood on Ed Woodward's ranch are some small springs (48). Used by a hunting camp, the water flows 1.0 kilometer. The discharge was 1.6 lps on July 25, 1955, and January 5, 1979.

Five kilometers farther west is a group of fresh-water springs (49) called **Kirchner, Custer, Screech**, and **Ratliff Springs**. On January 26, 1939, their discharges were 8.8, 8.5, 0.95, and 3.8 lps respectively. Custer Springs, where an old hunting lodge was located, had a flow of 3.2 lps in 1955. Near Ratliff Spring is a burned-rock midden.

Farther west, at latitude 29°41' and longitude 100°16', were **Pecan Springs (51)**. On Preston Sights' ranch, leased by Bruce and Dub Glynn, they have long been dry. Sam Raney lived here for a time. Several old maps depicted these springs, indicating their importance in early days. According to Sights, in 1923 there was still a pool of live water here.

Ten kilometers west of Pecan Springs are **Cherry Springs (30)** on Cherry Creek. They are on Mrs. Neville Smart's ranch. According to Mrs. Smart, her grandmother made preserves from the wild cherries which grew here, and still do. The old rock house still stands near the springs. On February 7, 1939, the discharge was 1.1 lps. The springs are reported still to flow well.

Pipe Springs (31), also on the Smart ranch, flow from a pipe in a bluff on the West Nueces River, about 12 kilometers north of the Kinney County line. Burned-rock middens are nearby. The discharge of about 6.3 lps of fresh water has remained the same for many

years.

Kickapoo Springs (15) are about 15 kilometers north of the Kinney County line on the east side of the West Nueces valley, on Jane Flato's ranch. They are also called South Kickapoo Springs to distinguish them from the Kickapoo Springs in Tom Green County. The main springs issue from a boulder bed on the Edwards limestones at an elevation of 535 meters, flowing into a lake on the West Nueces River. (See Plate 12, b). They were well described by Hill and Vaughn in 1898:

> Enormous springs break forth, creating a wide, running stream of clear water that continues for four miles, and then disappears into sink holes,

Other springs appear in the Nueces River bed one kilometer upstream and one kilometer downstream. A large Indian village was located on one point southwest of the springs. In 1873 Seminole scouts and the Fourth Cavalry ambushed a band of Comanches and Kiowas here, killing nine and capturing 61 horses. The water is now used to irrigate 24 hectares of pasture. Discharge records for the main Kickapoo Springs in lps follow:

May 29, 1931	56	Dec. 14, 1954	56
Jun. 18, 1931	54	Sep. 11, 1955	51
Feb. 6, 1939	63	1962	51
Sep. 9, 1952	42	Jan. 2, 1979	42
Aug. 21, 1953	37		

On January 2, 1979, in addition to the main Kickapoo Springs discharge, there was a flow of 43 lps from the upstream springs and 15 lps from the downstream springs. The springs are reported to have continued to flow during the 1950s drought. Bass and catfish thrive here. Deer, antelope, and killdeers frequent the site. Live oaks heavily infested with ballmoss and cypress trees, rare in this county, shade the waters.

Four kilometers southeast of Kickapoo Springs are a second group of **Bluff Springs (32)** on O. L. McNeally's ranch. Flowing into Bluff Creek, they produced about 25 lps on August 2, 1954. They are reported still to flow at about the same rate.

EL PASO COUNTY

Although existence in the El Paso County area was always precarious for man because of the frequency of disastrous droughts, there is ample evidence that a hunting and gathering people lived here at least 15,000 years ago. By 1590, when De Sosa and others began to explore the area, an agricultural people called Jumanos or Mansos lived here. These people used the waters of the Rio Grande for irrigation of crops and the springs in the nearby mountains for drinking water. They also dug shallow wells in the floodplain to obtain pure water.

One of the earliest settlements in Texas began with the construction of the Ysleta mission in 1681 following the retreat of the Spaniards from New Mexico during the Pueblo Revolt. The Tigua Indians who accompanied the Spaniards in their withdrawal from New Mexico still live at Ysleta.

Horgan (1854) described a typical drought on the Rio Grande in the 1840s. The residents of El Paso found it necessary to dig holes 3 meters deep in the dry river bed in order to tap a little groundwater for domestic use. In 1859 at Camp Concordia (a forerunner of Fort Bliss), water was hauled in barrels daily from the river and the mud allowed to settle before it was used for drinking purposes. This was a foolhardy practice which undoubtedly caused much sickness. Later the spring waters from the Franklin Mountains were used by the growing settlement at El Paso.

Hueco (Hollow) Tanks (4) are about 35 kilometers east-northeast of El Paso in a state park. There are no springs or seeps here. There are a group of igneous rocks which contain natural depressions or *tinajas* which collect rainwater. A Folsom man dropped a spear point here some 10,000 years ago. More recently the Pueblos and Mescalero Apaches painted many pictures on the rock walls. Some show mountain sheep, which formerly roamed the area. Still frequenting the tanks are about 150 species of birds, tiny shrimp in the water, and an occasional gray fox, bobcat, mountain lion, and golden eagle. In 1849 Capt. R. B. Marcy stopped at the tanks while exploring for a route to the west. The Butterfield Overland Mail maintained a station here in 1858 and 1859.

El Paso County's springs issue chiefly from Ordovician sandstones and weathered granite on the slopes of the Franklin Mountains. There is much evidence that the potentiometric surface of water in the artesian aquifers has declined greatly due to man's activities, both in the mountains and in the bolsons. Mining has had its effect in lowering water tables and causing the failure of springs. One mine pumped 52 liters per second of water day and night. The area has been terribly overgrazed. This has caused the destruction of the luxuriant natural grasses and their accompanying thick organic mulch which formerly retained water until it could sink into the underground formations. Now little vegetation is left except creosote bush, cactus, and yuccas. The mountains have also been used for target practice by Fort Bliss, with great damage to the soils and vegetation. The result has been that most of the springs in the Franklin Mountains have failed.

The little spring water available is of high quality. It is

of a calcium bicarbonate type, and usually fresh, very hard, and of neutral pH. Most of the writer's field studies were made during the period April 18 - 23, 1976.

Mundy Springs (2) were 19 kilometers north of El Paso, on the east slope of North Franklin Mountain. They have been dug out in attempts to revive the flow, but have now dried up. A small grove of cottonwoods, walnuts, and willows still identifies the site, with red paintbrushes and grapevines. Rattlesnakes may be seen, but little other wildlife survives. In 1890 bandits stole some horses from these springs. In the resulting chase Marshal Charles Fusselman was killed. The nearby Fusselman Canyon and Fusselman dolomite were named for him.

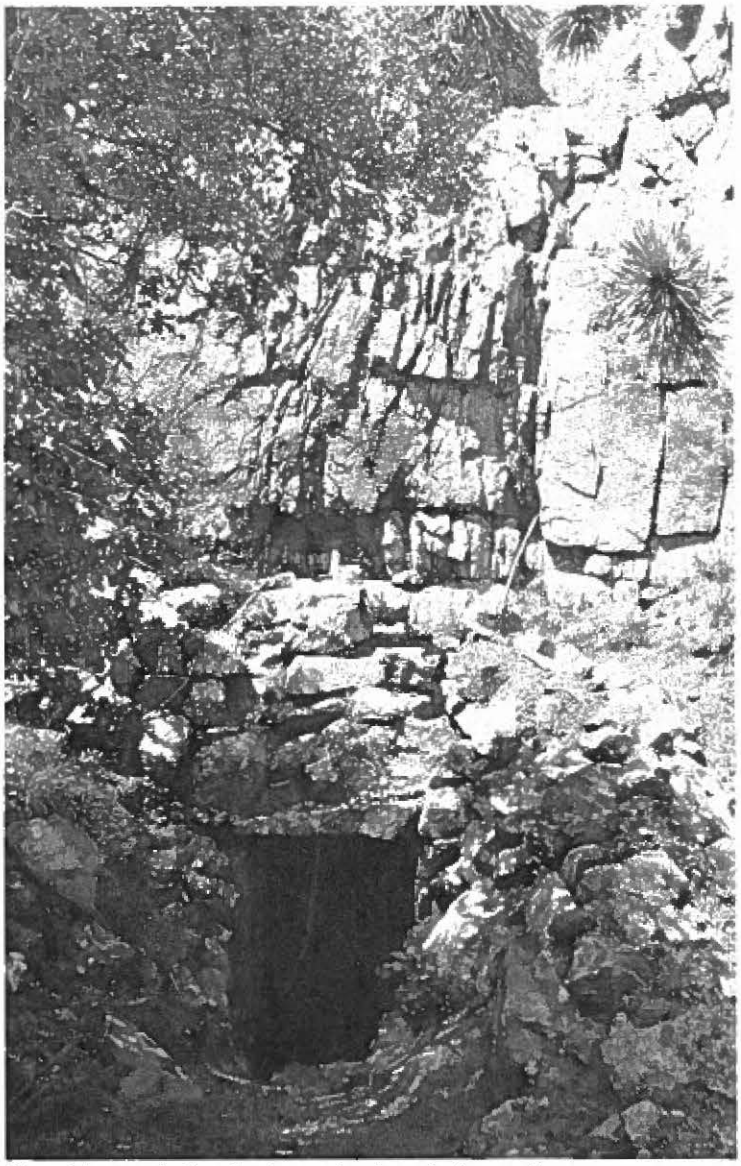
Indian Springs (3) were located three kilometers southeast of Mundy Springs. They flowed from weathered Precambrian granite. An intrusive dike forms an underground dam which formerly caused the springs to appear at this point. As their name implies, they were once a favorite haunt of Indians. A well was dug at the springs and pumped to provide stock water until it went dry. As a consequence Indian Springs are no more. The wild life which depended on the springs has disappeared, with only a few lizards making an appearance now.

Cottonwood Springs (1), the only ones still flowing, are 17 kilometers north of El Paso and one north of the transmountain highway on the east side of the Franklin Mountains. The water issues from Precambrian sandstone of the El Paso formation at an elevation of 1,730 meters, coming to the surface on top of an impervious limestone bed which dips steeply to the west. On April 20, 1976, the flow was 0.30 liter per second, the water running for about 50 meters before disappearing into boulders and cobbles. A small grove of cottonwood and other trees grows at the springs, which are very popular with hikers and picnickers in the area. Nearby are some Indian petroglyphs which date from about 1350 A.D.

In the past there were springs also on the west flank of the Franklin Mountains, especially east of Tom Mays Park. In 1891 a topographic map showed another Cottonwood Springs to be flowing here. The springs on the west side are all dry now.

FANNIN COUNTY

Archeological investigations in the areas of Lake Bonham and Bois d'Arc Reservoir have revealed Plainview-like projectile points and other artifacts which indicate that sites near springs were occupied by prehistoric people as much as 9,000 years ago. At the



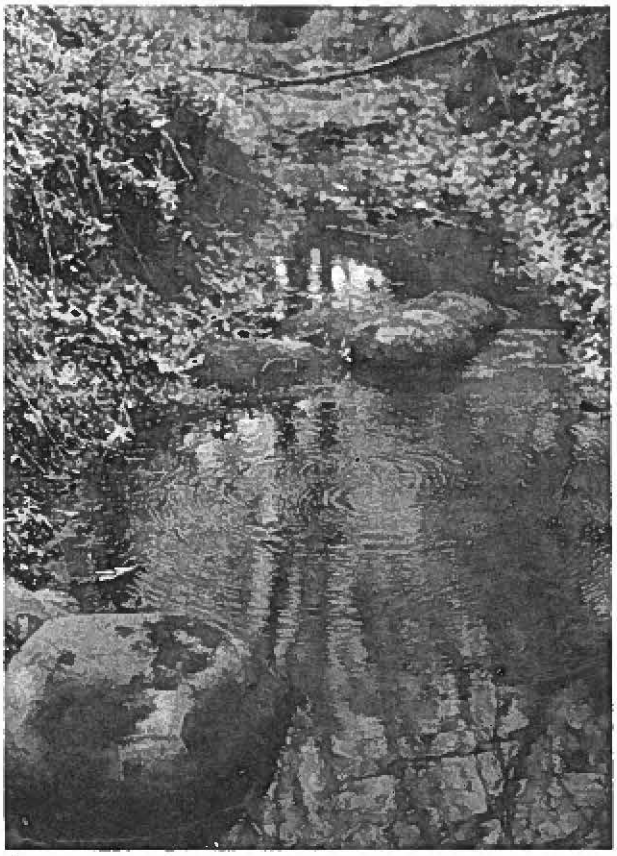
Site of former Indian Springs, showing shallow well entrance in the foreground and intrusive dike in the background.

dawn of historic time the agricultural, mound-building Kadohadacho tribe of the Caddo confederacy were living at the springs and along spring-fed creeks.

In the 1700s the first European explorers and traders began to make contact with Caddoes in the area. There are legends of Spanish gold buried somewhere northeast of Bonham. About 1816 the first Anglo-Americans penetrated what is now Fannin County to hunt buffalo and other game. In 1836 permanent settlements began to be established near the better springs.

The springs in the county issue chiefly from Upper Cretaceous sand and silt and from river terrace gravel and sand. Heavy well pumping in some areas has caused the groundwater table to fall. This has brought about declining spring flows and the failure of many former springs. Most of the writer's field studies were made on March 10 - 15, 1976.

The spring water is of the sodium bicarbonate type, usually fresh, soft to moderately hard, and of neutral



Septarian concretions at Bryant Springs.

pH. The content of iron or sulfate may be objectionably high, but was often considered beneficial to health by early residents.

Warren or **Hart Springs (13)** are located two kilometers northeast of Ambrose on Don Whitlock's farm. On December 22, 1976, they were flowing 0.55 lps from river terrace gravel amid a lush growth of bitter-cress. Here in 1837 the Old Warren post was established to trade with the Kiowa, Wichita, Tonkawa, Caddo, and Choctaw Indians. At that time the Red River was adjacent, but it has now moved about a kilometer to the northeast. A ferry was long operated here, and the place was later known as Kitchen's Fort. In the 1880s a houseboat tied up here still served as a grocery store. To the American Indians and the early settlers these springs were very important. The trace of the old ferry road can still be seen. Numerous smaller springs occur nearby. Four kilometers south, near Old Warren church and cemetery, springs (10) formerly issued from the Woodbine sand, but they are dry now.

At Sowell's Bluff, where Highway 78 crosses the Red River, are **Lowell Springs (8)**. Several very small springs flowed 0.25 lps in 1976 from river terrace sand on top of the Eagle Ford shale on both sides of the highway. They were used by travelers on the old ferry which operated here until 1936. The spring-fed Cottonwood Creek, which was flowing 6.5 liters per second on March 13, 1976, was undoubtedly also much employed by early settlers, as it enters the Red River close to the old ferry crossing.

Bryant Springs (7), seven kilometers north of Telephone on the Red River, are the largest remaining in the county and the most interesting from a geologic point of view. They were much used by travelers employing the old Bryant ferry here, and later the highway bridge. The springs, flowing 2.1 liters per second in 1976 from the base of the river terrace sand on top of Eagle Ford shale, were formerly enclosed in rock walls. Numerous septarian concretions are present. These concretions or nodules are often cut and polished, exposing a beautiful array of calcite crystals in the cracks or veins. The highway no longer passes the springs and they are somewhat difficult to reach. It is best to stop in Telephone for directions.

The most scenic spot in the county is probably **Bois d'Arc Springs (6)**, five kilometers southwest of Monkstown and two northeast of the Lake Coffee Mill dam. They were described by Hodge in 1966:

> This area has been a popular camping ground for more than 125 years because of the timber, wild game and ever-flowing springs of pure water. Indians first inhabited this area and left many of their burial mounds still visible along the countryside.
>
> . . .
>
> Huge native rocks mark the springs where boys have carved their names for more than 120 years. The springs themselves have been a source of supply for both man and beast. Pioneers often thought the springs had medicinal value and rode for miles to bathe and drink there.
>
> The first white man to own the springs and surrounding land, William McCarty, took his headright grant on either side of the creeks in 1836.
>
> Many saw mills have been operated on the . . . land. In the early 1900s men and boys enjoyed hunting and fishing there. Today the land is still as primitive as it was in the days of Indians. An all-weather road with a bridge over Bois d'Arc Creek runs near the time-worn rocks.

The springs flowed from the base of cliffs of Bonham sandstone on top of Eagle Ford shale along Bois d'Arc Creek. At the time of the writer's visit, in March 1976, they had been reduced to seeps, due in part to very dry weather during the preceding six months. But the dogwoods were in bloom and the setting is quite beautiful, even without the springs.

Bois d'Arc, incidentally, is French for *bow wood*. Being very resilient, this wood was preferred by the Caddoes for bow construction. It was also much usec

by the settlers for hedges and rot-resistant fence posts. It is called Osage orange or hedgeapple in other parts of the country.

Twelve kilometers north of Honey Grove and two west of Selfs were **Pinckney Selfs Springs (12)**. In 1836 this was the site of a Shawnee village. Thick sand beds in a gullied area of the Bonham formation are still slightly damp, but the springs have not flowed for some time. The site is now in idle grassland surrounded by cedar, red and water oak, bois d'arc, and other trees.

Fifteen kilometers north of Windom and just west of the **Gum Springs** church are the springs of that name **(5)**. They are now reduced to seeps from Quaternary sand.

Eight kilometers north of Dodd City are **Cross Springs (9)**. Flowing from Quaternary sand, they were formerly much used by residents of the surrounding area. In 1976 they supplied some ponds where ducks and beavers are numerous, at the rate of 0.25 lps.

The springs at Spring Hill (3) are five kilometers northwest of Windom. Flowing from Brownstown silt at 0.10 lps in 1976, they were probably never large, but were used by settlers in the 1830s. They are the source of Spring Branch.

In 1836 Dave Crockett camped by some springs at a grove of trees in the prairie. As there were swarms of bees in the trees, he named the place Honey Grove, and the name stuck. The locality had been visited by bison hunters as early as 1816. In the 1840s **Honey Grove Springs (4)** furnished water for several millponds. Some of the trees in the grove may still be seen, along with the millponds, just north of the town of Honey Grove. The springs, flowing from Gober silt, failed in the 1950s and have not flowed since. They were on the property of Jim Black, the authority on history of the area.

Flag Springs (1) are five kilometers south of Windom. They discharged 0.05 lps in 1976 from Ozan silt on top of the Roxton limestone, which has been sculptured into strange shapes by the water. Popular with early settlers in the 1840s, the springs now furnish water to stock animals.

Five kilometers southwest of Gober are **Shawnee Springs (2)**, the source of Shawnee Creek. Like Flag Springs, they issue from Ozan silt on top of water-worn Roxton limestone. In 1976 their flow was 0.35 lps. In 1542 the Spanish explorer Moscoso may have stopped here. He reported a Socatino Indian village, probably in this vicinity. The Shawnee Indians lived at these springs for a time in the 1830s. There are similar very small springs on Spring Creek two kilometers west.

Three kilometers south of Trenton are **Indian Springs (11)**, the source of Indian Creek. This was once a favorite haunt of the Caddoes. In 1850, when settlers began to arrive, this area was known as *Wildcat Thicket*. The springs trickled 1.1 lps in 1976 from Gober chalk and silt.

FAYETTE COUNTY

Fayette County's springs discharge mainly from Eocene and Miocene sands. The Eocene sands include the Cook Mountain through the Whitsett formations. The Miocene formations include the Catahoula, Oakville, and Fleming sands. These beds dip to the southeast at about 20 meters per kilometer. The Luling-Mexia fault zone in the northwest part of the county controls the location of some springs. A few springs also pour from terrace sands and gravels, especially along the Colorado River.

The county's springs were used for many thousands of years by early Americans before the settlers from Europe brought this long accord with Nature to a close. At the Frisch Auf site the remains of many burials and projectile points used by these people have been found. This site was near Monument Springs, demonstrating once again that early man greatly prized pure drinking water. In 1690 the Spanish explorer Alonso de Leon is believed to have crossed the Colorado River near La Grange (Bolton, 1908). As Solis described the country in 1767 (Forrestal, 1931),

> Here and there through these woods there are clearings with springs, and in these spots we saw very large numbers of bulls, cows, calves, bison, deer, turkeys, quail and partridges. In many parts of the woods there are bears, that feed on nuts, acorns and other things that grow on those trees. In the summer the bears get very fat on these things and during the winter months seek shelter in the hollow of some tree. . . . In these woods there are horseflies, known as Apaches, that are as easily provoked as wasps or bumble-bees (both of which are also very numerous), and whose sting is even more painful and more dangerous than that of these insects. Here we found ash-trees, oaks, elms, walnuts, vines, sassafras, excellent *zocosotes*, storax, various species of blackberry, pomegranates in large numbers, medlars, hazelnuts, chestnuts, strawberry-plants, laurels, *tarais* [salt cedars] and many other trees and plants.

But in recent years all this has changed. The proliferation of water wells pumping from the aquifers has lowered water tables as much as 30 meters, and caused most of the springs to decline sharply in flow or to dry up completely. From 1828 to 1842 Woods' Fort, the fortified residence of Zaddock Woods, 3 kilometers west of West Point, obtained its water from adjacent Robinson Creek. The creek is now completely dry except during storm runoff periods. Similarly, in the years

Ruins of the Kreische brewery at Monument Springs.

following 1831, William Rabb's grist mill, 9 kilometers northwest of La Grange, received its power from spring-fed Rabbs Creek. This creek also is now dry except for some water standing in pools.

The spring water which remains in Fayette County is of high quality. It is fresh, alkaline, usually hard, and contains mainly calcium and sodium bicarbonate. It is normally high in iron and silica content, and is healthful for human consumption. Most of the writer's field studies were made during the period October 1 - 6, 1975.

Primm Springs (1) are five kilometers west-northwest of West Point, just southeast of the old Primm cemetery. They gush from terrace gravel on Bartons Creek on Walter Peterson's farm, leased by C. H. Hilter. These largest springs in the county poured out 30 lps on October 4, 1975, and 16 on April 22, 1978. They were the reason that the Primm community was located here. In early days water was hauled in barrels from the springs to homesteads many kilometers away. The many springs make a very boggy area on the terrace slope, in which grow numerous ferns, pennywort, and arrowhead plants.

Monument Springs (2) are a group of springs issuing from a very steep bluff of Oakville sandstone about three kilometers south of La Grange, near the state park. In 1766 Marquis Cayetano Maria Rubi may have refreshed himself here while on an inspection of Spanish presidios and missions. In 1838 the five commissioners selected to find a new seat of government for the Republic of Texas recommended a site across the Colorado River from these springs. Part of their report reads

> about the center of this survey rises an interesting spring running down a decent, or arm of the bluff to the river, forming a passway to and from without difficulty, thus affording perhaps the best place for a bridge on the River, taking into view the banks timbers and inexhaustable stock of building Rock. Three quarters of a mile back commences a high smoth timbered plane running back six miles in all . . . on this survey there are three other springs said to be permanent, all of which rise seventy or perhaps eighty feet above the lands alluded to thus affording by the construction of a bridge great facilities for water privileges.

Two years later Bonnell (1840) stated

> Just below the mouth of this [Buckner's] creek, upon the west side of the river, is a high bluff known in the neighborhood by the name of Mount Maria. It is about five hundred feet in height, and commands a magnificent prospect. Upon the top of the hill is a spring, the water of which, in its descent, forms a beautiful cascade. At this cascade is found a great abundance of limestone spar — the most beautiful of all mineral formations. With proper improvements this would be one of the most magnificent situations in any country.

Bonnell's description was reasonably accurate, except that springs do not rise from the top of a hill. Rather, they issue about halfway up the bluff, at an elevation of about 130 meters. From 1860 to 1887 the Kreische Brewery used the springs. The remains of the brewery may still be seen at the Frisch Auf development. The springs have now all but disappeared, flowing 0.12 liter per second in 1975.

Rutersville Springs (3) provided water for Rutersville College, the first Protestant college in Texas, in 1840. Flowing from the Oakville sandstone, they were located at the college, one kilometer southeast of present Rutersville. There are many pumping water wells in the vicinity now, and as might be expected, the springs have ceased to flow.

About 10 kilometers southwest of Round Top and three northwest of the Big Spring Hill church, was **Big Spring (4)**. It was once called **Castleman Spring** for Sylvanus Castleman, who built a cabin here in 1824. Later it was known as **Manton Spring** for the owner at that time. Also called **Spencer Pool**, it flowed from the Oakville sandstone. It provided a reliable source of water to the settlers in the area during the 1840s. It is now covered by 10 meters of water in a flood-prevention reservoir. It probably no longer flows. On October 5, 1975, there was no outflow from the reservoir. The spring is reported to have continued flowing, the 1950s.

Eleven kilometers northeast of Fayetteville, and on the northeast side of the **Willow Springs** community, were the springs of this name **(9)**. They were the reason that the settlement was established here in 1833. They flowed from Fleming sandstone, but now have been

reduced to pools of stagnant water. Some large willow trees still mark the location.

The settlement of High Hill, established in the 1830s, is five kilometers northwest of Schulenburg. **High Hill Springs (7)**, on the east side of the settlement, flowed 0.05 lps in 1975 from Fleming sandstone. They formerly flowed much more copiously than at present, and once supplied a brewery.

On the opposite side of Schulenburg, five kilometers southeast, is the Lyons cemetery. It marks the location of the settlement which began in the early 1830s. **Lyons Springs (8)**, which sparkled south of the cemetery, are dry now. Emil Sommer, who lives just to the north, remembers when they stopped flowing, around 1923.

Blackjack Springs (5) are 15 kilometers southwest of La Grange and one west-northwest of Blackjack cemetery. They are on T. A. Raemdonck's farm, leased by Paul Selzer. They were much used by early settlers of the Blackjack community. In 1842 the springs provided an overnight stop for Captain Nicholas Dawson and his company, en route from La Grange to engage the Mexican forces. All were killed at Salado Creek near San Antonio. Several springs issued from Catahoula sand on clay along Rocky Creek, at 0.11 lps on April 22, 1978. When the water table was higher, the springs were probably closer to the cemetery and old settlement. Blackjack oaks still thrive here, along with cedars. Ducks, water snakes, and 20-centimeter sunfish live in the pools.

Four kilometers northeast of Flatonia is **Pine Springs** cemetery. This is all that remains of the Pine Springs settlement, established about 1840. The springs (6) still flowed 7.0 lps on October 4, 1975, from the Catahoula sandstone, but no pine trees have survived.

Four kilometers southwest of Flatonia are **Cedar Springs (11)**, the source of Cedar Creek. Two groups of springs rise from Whitsett sandstone. That they were important to early residents is manifested by their appearance on maps such as Spaight's of 1882. On February 13, 1977, after heavy rains, they were producing 5.1 lps. Reportedly they have never ceased flowing.

Cistern Springs (12) are some small springs just west of the Cistern settlement. They were important enough to be depicted on an International and Great Northern Railroad map of 1882. The water issues from Yegua sandstone, coming to the surface along a fault. On February 13, 1977, after much rain, they flowed 0.75 lps, but they no longer flow in dry periods.

Sloan Springs water falling over thin-bedded dolomite.

FLOYD COUNTY

In days gone by the groundwater table was close to or at the surface throughout Floyd County. The overflow of groundwater beyond that needed for recharge burst forth in the form of springs in all of the low areas, but especially in the canyons below the caprock. This was the scene which greeted Arthur Duncan and his family in 1884, the first white settlers in the county.

The situation has changed now. Irrigation pumping is "mining" the groundwater beneath the plains, water tables have declined sharply, and there is no longer overflow to form springs. Thus in the name of "progress" we have effectively destroyed the county's springs, which were formerly the centers of lush vegetation and abundant wild life. The canyons are being converted into a waterless desert. The story of springs in Floyd County is largely one of springs which were important in the past, but are no more.

The springs of the county issued chiefly from the sands and gravels of the Ogallala formation which underlies the High Plains. To some extent they were supplied also by the underlying Triassic Dockum sandstone. Their waters were of good quality, essentially the same as that which is still being pumped for irrigation. The water was fresh, very hard, and alkaline, being primarily a calcium bicarbonate type.

Blue Hole Springs (2) are on Quitaque Creek 10 kilometers east of South Plains, on J. P. Taylor's ranch. They were popular with prehistoric people. Many Alibates and other flint flakes litter the vicinity. Eight kilometers downstream, near some other springs called Quitaque Springs, was a Spanish-Mexican village site. Here New Mexico traders or Comancheros traded with the Comanches. Lead, powder, guns, and whiskey were exchanged for the Comanches' cattle and human captives. A Folsom point found here indicates that the site was popular as long as 11,000 years ago. A few kilometers farther downstream was Camp Resolution, a base used by the Santa Fe expedition in 1841. Blue

Hole Springs trickled from Ogallala sand on top of a blue Triassic shale which formed the "blue Hole." Discharge measurements in lps are:

Nov. 4, 1938	14	June. 18, 1975	0.63
Dec. 10, 1968	13	Jul. 16, 1978	0

The hole has now been partially filled with gravel and cobbles. Cottonwood trees, plum thickets, and grapevines still survive. Many irrigation wells pump within two kilometers of the site.

Bain Springs (3) were 14 kilometers southwest of Flomot, in the rough country just below the caprock. Until 1968 they were reported to be flowing at elevation 855 meters, but they are now very dry. Many irrigation wells to the west have contributed to their demise. Flow records in lps are as follows:

Aug. 24, 1938	6.3	Dec. 14, 1968	7.9
Nov. 18, 1938	6.7	Dec. 9, 1975	0

Montgomery Springs (4) were in Blanco Canyon just north of the Crosby County line. Nearby are the remains of Thomas Montgomery's 1887 "dugout" home. As wood was scarce in this area, early homes usually were underground dugouts. The present owner of the ranch, Monte Williams, says that the springs, and others nearby, ceased flowing about 1948. An old well is still at the site.

Massie Springs (1) were 10 kilometers southwest of Floydada. They and several nearby springs furnished the water for prehistoric men and their families at the Floydada Country Club archeological site two kilometers downstream. (See Plate 7, b). Folsom projectile points found in the vicinity indicate that the site was used at least 10,000 years ago. The artifacts uncovered indicate occupation at various times up to the historic period. This was probably also the point where the Comanches under Quanah Parker (son of Cynthia Parker) crossed the *Blanco* (White) Canyon during Mackenzie's campaigns of 1872 and 1874. Gillespie called them **Head of running water** on his 1875 map.

In 1938 the springs were reported as "numerous seeps from the bed and bank of the stream." They are believed to have ceased flowing about 1945. A grove of large cottonwoods still survives at this location.

FOARD COUNTY

The fresh-water springs of Foard County issue primarily from Quaternary wind-blown sand deposits and river-terrace sand and gravel. Springs containing water that is high in sulfate pour from Blaine gypsum, Whitehorse sandstone, and other Permian formations.

Groundwater tables have fallen as a result of man's activities in the county. Irrigation pumping has been the greatest offender. As a result, many springs have weakened or failed.

In addition, severe erosion, especially gully erosion, has filled many stream channels with sediment. This has buried some springs.

Much of the county is underlain by gypsum or gypseous soils. Because gypsum is very soluble in water, reservoirs or tanks built in this area usually develop leaks and will not hold water. Thus, in addition to the shortage of groundwater, it is difficult to store surface water.

The spring water is generally of a calcium sulfate type, fresh or slightly saline, very hard, and alkaline. The sulfate content may be high enough to cause diarrhea in humans and may be so high that livestock will not drink the water.

Most of the writer's field studies were made during the period July 14 - 19, 1979.

Sloan Springs (16) are 11 kilometers west-northwest of Crowell on H. N. Ekern's ranch, leased by Don Ray and Betty Borchardt. In 1877 buffalo hunter Jones Vaughn and his party killed six Indians camping at the springs. Later, at the R2 ranch near Chillicothe, a stranger killed the camp cook and then disappeared. He was trailed to Sloan Springs by the R2 cowboys and shot. In more recent days the springs were popular for picnics. The washed-out bridge of the old Crowell-Paducah road stands adjacent to the springs.

Feeding Sloan Springs Creek, the water trickles from cavernous gypsum on dolomite. Moss covers the dripping rocks. Frogs swim among the cattails, shaded by salt cedars and willows. On July 17, 1979, the discharge was 1.1 liters per second.

Blue Hole Springs (8) are 21 kilometers west-northwest of Crowell and three north of Highway 70 on Warren Haynie's ranch. Pouring from Blaine gypsum, the water gives rise to Blue Hole Creek. Shortly after Jones Vaughn's massacre of the Indians at Sloan Springs in 1877, the Indians struck back, killing two of Vaughn's teamsters at the Blue Hole and capturing 7,000 buffalo hides. The springs watered a large section of the county until they were fenced off in 1897. Baptisms were frequently held here. Hendrix's description of the place (1964) cannot be improved upon:

> I have been many places and seen many things, but in the late afternoons of the present day my mind returns most often and most pleasantly to the old days when the sun was a couple of hours high and I would ride across the flats that led down to

> the Blue Hole. As I ride in memory, I check the flats for the cows that I know have "used" there year in and year out, and note with pleasure that there is a fair sprinkling of calves among them and not a case of worms in the whole bunch. As I ride up to the hole of water with its bluff high to the back of it and a gravelly beach to the front, the kildees chirp and dance along the water's edge. Brown bullbats swirl and dip while a lordly brown-backed bull, paying court to a mellow-eyed heifer, sends clouds of dust skyward over his shoulder as he challenges with a mighty bellow another of his kind coming in to water. Down under the willows at the lower end of the hole where the waters run shallow, matronly cows, keeping an eye on their offspring, stamp and switch their tails in bovine satisfaction. As my horse slakes his thirst, I note the trail made by the water snake wiggling his way back to the shelter of the overhanging rocks, and the turtles up for a sunning as they slide into the water. Up near the boxed-up spring I note three or four immigrant wagons making camp for the night.

Blue Hole Springs water was used by households in a large surrounding area. Women washed their clothes and their hair here. Many roundups were held at the springs. In the drought of 1917-18, wagons came great distances to fill barrels at the springs, which are reported never to have dried up. Much of the spring water was used for drilling oil wells and in the construction of Highway 70.

On July 17, 1979, the spring flow at Highway 70 was 0.85 lps amid water milfoil, cattails, and rushes. Three kilometers farther downstream, at Highway 654, the discharge was 0.65 lps. Two kilometers south of Highway 654 and west of Blue Hole Creek is the "monument." This four-meter-high stone monument was probably built by buffalo hunters to mark the location of **Monument Hole (4)** in the creek. In 1786 Pedro Vial probably stopped here on his return from San Antonio to Santa Fe. (See Plate 3, c).

Four kilometers northeast of Blue Hole Springs are **Half Circle Springs (6)**, on Claudius Carroll's ranch. Here in the 1880s Crow Wright built several dugouts, the remains of one of which can still be seen. Many projectile points have been found nearby. The water seeps from Blaine gypsum on shale. On July 18, 1979, the discharge was 0.72 lps. According to Carroll, the springs must sometimes be cleaned out with a dozer because of soil erosion upstream.

Coyotes and quail live among the rushes, cattails, water milfoil, and bluebells, the last of which are becoming scarce. The springs feed an earth tank which no longer holds water. In the area to the west are about 24 sinkholes in gypsum, through which recharge of the spring water takes place. These sinkholes are usually marked by hackberry trees. The similar Dripping Springs are four kilometers southeast.

Talking John Springs (9) are in northwestern Foard County at latitude 34°10' and longitude 99°58' on Robert Kincaid's ranch, operated by Howard Ferguson. They pour from Blaine gypsum along Talking John Creek in a deep ravine. On June 1, 1936, they delivered 6.3 lps. On July 18, 1979, the discharge was 3.4 lps. Eyeless catfish have been found in the caves from which the springs emerge. Minnows and caddis flies live among the rushes, shaded by willow and hackberry trees.

Five kilometers southeast of Talking John Springs are **Seven L Springs (7)**, on Anne Burnett Tandy's ranch, looked after by Earl Stermer. The slightly saline water trickles from Blaine gypsum in a ravine just north of the ranch headquarters, giving rise to Cactus Creek. On June 20, 1936, the discharge was 6.3. On July 16, 1979, it was 0.34 lps. Cottonwood and willow trees, grapevines, plum thickets, and rushes are abundant. Nearby are numerous gypsum sinkholes, through which recharge to the springs takes place.

In northeast Foard County along the Pease River and near the Santa Fe Railroad is a group of springs which emerge from river terrace gravel. They are recharged through the terrace, which is five kilometers or more wide along the south side of the river. They include **Ross (11)**, **Bledsoe (12)**, **Dunn (13)**, and **Santa Fe Railroad (14) Springs**.

Ross Springs are four kilometers west of the railroad crossing on Edwina Halencak's farm, leased by J. B. Fairchild. On October 16, 1940, 1.3 lps issued from them. On July 17, 1979, the discharge was 0.15 lps. About 50 head of cattle use the water, which flows among rushes, water cress, and plum bushes.

Bledsoe Springs are about 500 meters east of Ross Springs on Joe Carroll's lease. Their discharge was 2.5 lps on October 16, 1940, and 0.95 lps on July 17, 1979. Large fish and frogs dart in the pools where water cress and crested ferns grow. Grapevines and plum thickets are numerous.

Dunn Springs are two kilometers west of the railroad crossing on Bobby Bond's farm. In 1881 W. T. Dunn and his family built a cabin here, keeping their milk and butter in the springs. On July 17, 1979, 1.3 lps poured from the gravel. In the channel bank can be seen three meters of modern sediment which has been blown and washed over the original black soil. Fish, frogs, raccoons, and quail thrive among the water cress, cattails, and duckweed.

The Santa Fe Railroad Springs are at the railroad crossing. On October 16, 1940, they poured out 0.63 lps, and on July 17, 1979, 1.0 lps.

Many other small springs trickle in this vicinity. Three kilometers southeast of the railroad crossing was the site

of a Comanche village near the mouth of Mule Creek. Here Cynthia Ann Parker was recaptured in 1860, unwillingly, from the Indians, with whom she had born two sons and a daughter during the preceding 24 years. Her son Quanah became one of the last Comanche chiefs. On July 17, 1979, spring-fed Mule Creek still flowed 0.55 lps at this site.

Six kilometers west of Rayland are **Ray Springs (17)** on Mrs. Mary Ray's farm. They trickle from Pease River terrace conglomerate and gravel. In 1884 Presley Ray built a cabin here and used the spring waters. On August 4, 1979, 0.25 lps flowed through a watering trough and 15 meters beyond into a bog. The water in an unused trough was covered with tiny green duckweed plants. Cattails and water cress are abundant, shaded by willow, hackberry, and pecan trees and plum bushes. Bees and damsel flies sip the water.

In the northeast corner of the county on Paul Baggett's farm are **Antelope Springs (15)**, just north of Rayland. In 1877 W. R. McCarty and two other men stopped here briefly. For this reason some maps call these **McCarty Springs**. Discharge records in lps include:

Jun. 6, 1936	38	Jul. 17, 1979	3.1
1944	6.3		

There are now two springs, one on each side of an old road which has been washed out by erosion. The 1979 discharge includes 0.65 lps from the west spring and 2.4 lps from the east spring. A hydraulic ram formerly pumped the water up to irrigate cropland on the terrace. The spring water flows from terrace gravel on Permian shale. Irrigation pumping from nearby wells is no doubt the cause of the great decline in the springs' discharge. Crested ferns, water cress, and duckweed adorn the pools.

Anchor Springs (10) are nine kilometers west-southwest of Crowell on George Self's ranch. Around 1885 the R2 ranch wagons camped here and watered their stock. The water, seeping from Blaine gypsum, contains too much gypsum for human consumption, but waters about 30 head of cattle, according to Self. On July 16, 1979, the discharge was 0.065 lps. In winter the water is reported to run 25 meters into an earth tank. It is sometimes necessary to clean out the springs with a dozer because of modern sedimentation. Scarce bluebells grow among the cattails and willows. Coyotes, bobcats, skunks, raccoons, turkeys, and rattlesnakes frequent the spot.

Mulberry Springs (2) are 13 kilometers northwest of Foard City on Virgil and Bonnie Johnson's ranch. Here may be seen the ruins of an old dugout built by J. W. Wishon. On July 16, 1979, there was seepage from Blaine gypsum in a small ravine. According to Virgil Johnson, there had been running water here one week earlier. A lone mulberry tree stands at the springs, along with willow and hackberry trees, rushes, cattails, and bluebells.

The similar **Buchanan Springs** are one kilometer east. **Cottonwood Springs**, five kilometers east-northeast of Mulberry Springs, are slightly stronger, running 0.8 kilometer in winter.

Boiling Springs (3) are in western Foard County, two kilometers southwest of Monument Hole, at latitude 33°59' and longitude 99°57'. They pour from Blaine gypsum at an elevation of 460 meters on Otis and Bettie B. Gafford's ranch. In the 1880s W. T. Dunn built a dugout here and carried the mail from Pease City to Teepee City, according to Bonnie Johnson, noted Foard County historian. Beavers once built their dams here, but have now been killed off.

On June 4, 1936, Boiling Springs' flow was 32 lps "from six openings along the creek bank." On July 17, 1979, the discharge was 15 lps. The slightly saline water has been much used for drilling oil wells. Soil erosion has filled the channels so that the springs must periodically be cleaned out with a dragline. Carp, gar, catfish, bass, and mosquitoes are numerous in the cattail- and rush-filled pools.

Recharge to Boiling Springs is through nearby sinkholes in the gypsum. One of these sinks collapsed a few years ago, according to Gafford, because of the solution and removal of gypsum below. Many other springs exist nearby, some of which no longer flow. The very small **Richards Springs** are six kilometers southwest of Boiling Springs. Outlaws once camped here.

Y Springs (1) are close to the Cottle County line, just south of the North Wichita River, at C. C. Burgess' Y ranch headquarters, managed by Glendon Wear. Several springs pour from Blaine gypsum and sandstone on shale. Indian living sites have been found near here. On July 14, 1979, the discharge was 17 lps. With the air temperature at 38° C, cattle were standing in the cool running water. Although the water is moderately saline, cattle will drink it. Salt cedars and cedars shade the brook where water cress thrives. Minnows, raccoons, turkeys, and quail are numerous. Recharge probably takes place through a flat area of about 10 square kilometers which lies to the west.

FORT BEND COUNTY

Because of the relative flatness of the land surface, large springs cannot be expected in Fort Bend County.

In the past, however, there were numerous springs and seeps along the Brazos and San Bernard Rivers and at some of the salt domes which formed topographic highs. These springs and seeps flowed chiefly from sands of the Beaumont and Montgomery formations and river terraces.

The Karankawan Capoques and their predecessors were the earliest users of the springs near the coast. They were expert at spearing fish by torchlight and at stupefying fish with the powder of certain roots and herbs, so that they could be killed with paddles. Farther inland near the springs were the Bidais, who pounded brier roots to make flour. In historic times the Choctaws, Coushattas, and Osages who had been evicted from their homes in the east and north, made their villages at the better springs and seeps. Many early Spanish and French explorers were familiar with the area's springs. When settlement of the county began in the 1820s, the first cabins were built at flowing springs and seeps, pending the digging of wells at a later date.

During the ice age, mammoths which were hunted by Paleo-Indians roamed the county. A 5.5-meter tusk was found along the Brazos River below Richmond. In 1836 a herd of about 3,500 bison was seen crossing the Brazos near Spanish Springs. Many other animals came to depend upon the county's springs and spring-fed creeks. These included leopards, panthers, bears, and wild horses, hogs, and cattle. Many of these animals are now extinct in this area. But to their credit the colonists in 1824 outlawed the killing of deer or wild mustangs for their skins alone. At that time most of the county was prairie, with dense forests along the spring-fed rivers. The wild peach, a species of laurel tree, was common.

Water tables have declined seriously, especially in the northeastern part of the county, where municipal and industrial pumping in the Houston area and pumping for rice irrigation are taking a heavy toll of the groundwater. Here the water table declined as much as 67 meters in the period 1890-1970. The Brazos River, formerly a spring-fed, gaining stream in Fort Bend County, has changed in recent years to a losing stream. The many flowing wells which wasted water early in this century no longer flow. As a result, of course, most of the springs and seeps in the county have long been dry. An associated damage related to water-table decline is land-surface subsidence, which can cause buildings to crack and pipe lines to break. This amounted to 0.70 meter in the northeast part of the county for the period 1906-1964.

The spring waters remaining are of a calcium or sodium bicarbonate type, usually fresh, hard, and alkaline. The iron content may be high. Some damage has been done to the groundwater by improper disposal of oil-field brines and by leaking well casings which allow salt water to enter fresh-water aquifers.

Most of the writer's field studies of the county's springs and seeps were made during the period March 2 - 7, 1977.

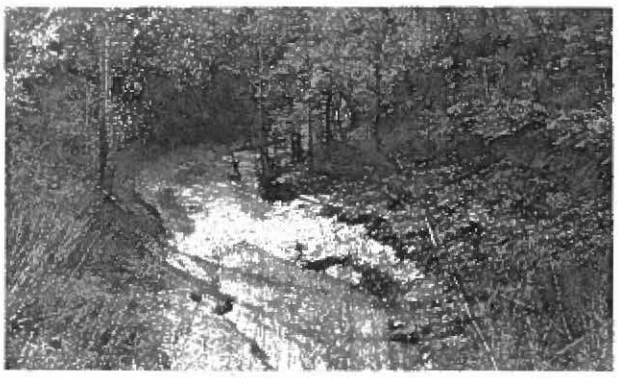
Former springs and seeps (2) probably were found just west of the 1824 Fulshear settlement and at the Pleasant Hill community five kilometers southeast of Fulshear. On the northeast flank of the Orchard dome, four kilometers southeast of Orchard, springs (12) probably flowed, but so much oil, sulfur, and water have been withdrawn that they failed long ago. Others (10) were near the 1822 Fort Bend at Richmond and near Jane Long's home (11) three kilometers east.

Historically the most colorful springs in the county, although they no longer flow, were **Spanish Springs (4)**. They were four kilometers north of Richmond, flowing from terrace sands in a draw on the north side of the Brazos River opposite the Rocky Falls ford. An eighteenth-century Spanish trail passed them, according to Mark Price, curator of the Fort Bend County Museum, and in 1836 Santa Anna's army stopped here on their way to San Jacinto.

Small springs or seeps (3) probably issued on the west side of Hodge's Lake, where a settlement was made in 1828. They may also have been used by Santa Anna's army in 1836.

Big Springs (5) are among the few which still flow in the county. They feed Big Creek in the eastern part of the county from Big Creek oil dome almost to its mouth. As might be expected, the Capoques were fond of this area. Louis Cummings, who lives near the mouth of Big Creek, has found several prehistoric mounds here.

At the Long Point dome, six kilometers northeast of Guy, springs and seeps (6) were probable in the past.



Site of former Spanish Springs.

Removal of great quantities of sulfur has caused the surface of this dome to subside and the springs to dry up. Other springs or seeps (7) rose just east of the cemetery at the old Routt Point settlement. The Spaniard Joaquin Orobio y Bazterra may have made a stop at these springs in 1746. Killdeers and geese are still common at the standing pools of water here. Another likely small former spring (8), where Santa Anna camped, was on Turkey Creek five kilometers east of Kendleton.

A group of springs (13) which still flow weakly are **Powell Springs**, north of the Powell's Point cemetery six kilometers southeast of East Bernard. On March 5, 1977, they produced 0.03 liter per second from sand in a wooded draw. They were no doubt a major inducement to the settlers who stopped here in 1831.

FRANKLIN COUNTY

Most of Franklin County's springs issue from Tertiary Eocene sands, especially the Reklaw, Carrizo, and Wilcox formations, which are found in the southern half. Some flow from Upper Cretaceous Navarro sands or from Quaternary terrace sands. The water-bearing formations dip toward the south at about 10 meters per kilometer.

The springs were used by prehistoric people for many thousands of years. Archeological investigations of the Lake Cypress Springs basin before it was inundated revealed base camps and farming, chipping, hunting, and gathering stations as much as 4,000 years old. In early historic times the agricultural Caddoes lived at the springs in the county.

Many natural lakes, teeming with fish and waterfowl, were formerly fed by springs. The prairies were covered at times with geese, and wild pigeons obscured the sun. Now the lakes are largely drained or silted up and most of the animals that depended upon the lakes and springs have vanished. In early days great damage was done to the land and springs by clearing and plowing. Today there is no longer any cultivated land in the county, but the scars of former plowing remain as gullied areas, partially healed and recovered with woods.

The spring waters are usually of a calcium or sodium bicarbonate type, fresh, soft, and acid. The iron or manganese content may be high. The writer's field studies were made chiefly during the period December 15 - 20, 1977.

Fannin Springs (1) are in south Mount Vernon at the city pumping plant on Highway 423. They were much used by early settlers in the 1840s. In the early 1900s many political meetings and other outings were held in Fannin's Woods at the springs, according to Mount Vernon attorney H. L. Edwards. The springs were used as a part of the city's water supply until around 1947. Now they seep from Wilcox sand into a rock-lined roadside channel fringed with water pennywort, and form the head of Town Branch. The discharge has remained constant at 0.95 liter per second in 1942, 1959, and 1977.

On the east side of Mount Vernon, north of the cemetery along Highway 67, are **Spring Branch Springs (2)**. They were essential in the 1840s to early settlers of Mount Vernon, which was first called Keith and later Lone Star. Many early residents washed clothes here and filled water jugs and barrels. An old wagon yard and sawmill were situated here. The water is now piped to several homes. The numerous springs cause a flow of about 1.0 lps through Mrs. Ted Tittle's place.

Red Branch is a small draw in the extreme northwest corner of the county. It received its name from the reddish Navarro sand, from which weak seeps (14) ooze into pools along the creek.

Hitchens Springs (5) are just southwest of Macon on Bill Hill's property. According to J. C. Pickens, a nearby resident, they were named for A. O. Hitchens, who arrived during a drought in the late 1860s and found them still flowing. Syrup, shingle, and grist mills were situated here at one time. The springs continued flowing throughout the drought of the 1940s. They are relatively inaccessible in a formerly cultivated wood. In 1977 0.13 lps seeped from Wilcox sand on a clay layer, giving rise to Macon Branch.

Glade Springs (4) are five kilometers south of Mount Vernon on Highway 21. In 1858 they were used by the nearby Smith school. Early residents of the area also filled water jugs here. In 1959 and 1977 0.13 lps seeped from Wilcox sand. The water is still piped to a nearby home.

Cypress Springs (6) extended along Big Cypress Creek beneath the present Cypress Springs Lake. Some probably still flow, even though they are opposed by the lake's head of water. They were a favorite haunt of prehistoric people.

Ten kilometers northeast of Winnsboro, just south of Good Hope cemetery, are **Spring Place Springs (12)**. Spring Place school, which was immediately south, used the spring water in 1907. The iron-bearing water is the source of Stouts Creek. The springs yielded about 0.55 lps in 1977 from Wilcox sand.

Clearwater Springs (7) are eight kilometers east-northeast of Winnsboro, just east of Clearwater cemetery. The Clearwater community, which began in the

1860s, was named for these springs. One is on Doyle Wall's farm. As a group, the springs produced 0.35 lps in 1977 from Carrizo sand in a grove of birch trees.

Four kilometers northeast of Winnsboro, on R. L. Krantz' farm, are **Rock Springs (8)**. Many Indian artifacts have been found here. The springs now seep from crawfish holes in Reklaw sand in a gully about 200 meters east of the Rock springs cemetery. The name indicates that the springs were once farther up the draw where rock is common, across Highway 1448 from Rock Springs school, which was just west of the cemetery. Interestingly, when Rock Springs school was later moved about 0.5 kilometer east, springs were present there also, just west of this school. They now seep from a concrete box at the upper end of a pond on R. C. Preston's farm.

Near the city water plant on the northeast side of Winnsboro on Dr. Larry Landers' property are **Winnsboro Springs (9)**. In the 1850s a Mr. Farris built a corn and flour mill which used the spring waters for power. In 1880 the creek at the mill was reported to be running "clear spring water" 2.7 meters wide and 0.6 meter deep.

Several springs issue from Reklaw sand at the base of a steep bluff to give rise to Brushy Creek. Appearing at an elevation of about 150 meters, the springs support an abundant growth of pennywort, marsh purslane, duckweed, mint, and parrot's feather. Some of the spring flow is diverted into Lake Wanda. Four Winnsboro municipal wells to the west have taken their toll of the groundwater and spring flow, as shown in the following decreasing discharges, in lps:

Feb. 14, 1942	6.3	Dec. 18, 1977	0.55
Jul. 17, 1963	1.6	Oct. 23, 1979	0.65

Just east of Lake Wanda and downstream are **Freeze Springs**, which once furnished an excellent, cool swimming hole.

Tanyard Springs below the mill at Winnsboro Springs were used in a hide-tanning operation. From 1898 to 1926 they supplied water to Winnsboro. In 1898, before many wells began pumping in the vicinity, it was estimated that Winnsboro and Tanyard Springs could furnish more than one million gallons per day (44 lps) of water.

Five kilometers north of Winnsboro is Lake Franklin, built by a hunting and fishing club. According to J. H. Connelly of Mount Vernon, the Caddoes had a village near the many springs (10) beneath this lake. When the dam broke some years ago, about 12 springs were counted in the channel near the middle of the lake. Since then the dam has been repaired and the springs again inundated.

Three kilometers south of the Purley community on Highway 37 are **Crystal Springs (11)**. They are in an attractive setting of rock walls, pools, and a fountain in a roadside park. According to Connelly the present setting was built around 1932 with WPA assistance. (See Plate 11, c).

Discharge records in lps are:

Jun. 11, 1942	0.19	Dec. 18, 1977	0.10
Jun. 11, 1963	0.19		

Pleasant Hill Springs (13) are three kilometers west of Purley and just west of Pleasant Hill cemetery. They served the early residents of the community from 1866 on. They became very popular as a meeting place and site of church revivals. In 1977 about 0.23 lps trickled from Wilcox sand in a wood.

Three kilometers south-southwest of Mount Vernon, near the intersection of Interstate 30 and Highway 37, are **Parchman Springs (3)** at Parchman's Bluff. Here, according to H. L. Edwards, many school picnics were held. About 0.21 lps issued from Wilcox sand on top of Midway clay in 1977.

GAINES COUNTY

Most of the springs in Gaines County flow or did flow from Ogallala and more recent sands. In a few cases water flowed from the older Fort Terrett limestone. In nearly all cases springs and seeps were located along the major draws and around the large lakes, where there was sufficient difference in elevation to cause a flow.

For many thousands of years the Paleo-Indians roamed this land, camping at springs in the county and following well-worn trails from one spring to another. In early historic times the Apaches had taken over this land, but they were later evicted by the Comanches. Early explorers such as Castillo and Guadalajara in the seventeenth century no doubt followed old trails or were guided to the springs along their routes.

Irrigation and oil-field operations have taken a terrible toll of the land. The soil is being blown away on land which should never have been plowed, polluting the air and causing great damage to health as far away as the Gulf Coast. Sand dunes drift across highways and homes. But the greatest calamity is the mining of the limited supply of groundwater for irrigation. During the period 1946-64 declines of up to 11 meters occurred. In another 25 years the groundwater will essentially be exhausted. As a result, most of the county's springs have now dried up.

The spring waters are of a calcium or sodium bicarbonate type, mostly fresh or slightly saline, very hard, and alkaline. The fluoride content may be high, causing mottling of teeth but otherwise no harm. Sodium, sulfate, and chloride contents may be objectionably high. The concentration of salts in irrigation return flows has caused the groundwater to become increasingly mineralized. An example is shown in the table of Selected Chemical Analyses for the Cedar Lake (Johnson) Springs, whose water increased in total-dissolved-solids content from 6,150 milligrams per liter in 1938 to 21,600 in 1963. In addition, oil-field brines and other industrial wastes have contaminated the groundwater.

Stirrup-high grama grass originally covered most of the area. Little mesquite was present. Bison, antelope, deer, wolves, coyotes, prairie chickens, quail, and wild mules and horses roamed the spring-fed draws and the vicinity of the lakes. With the disappearance of most of the springs, along with the plowing up of the natural habitat of these animals, many species have not been able to survive. Mesquite has done well as other native plants died out because of declining water tables, because its roots can reach down 53 meters or more.

Most of the writer's field studies were made during the period March 14 - 19, 1977, after several months of no precipitation.

On the Higginbotham ranch in northwest Gaines County there were formerly springs or seeps on Wordswell Draw at latitude 32°57' and longitude 102°57'. In 1650 Captains Hernan Martin and Diego del Castillo may have paused here on their journey from Santa Fe to the "River of Pearls" in present Tom Green County. In 1886 the place was called the **Boar's Nest Springs (10)**. Higginbotham foreman Herman Chaney has heard of the springs, but when he arrived here in 1955 they were already dry.

Downstream, about halfway between Boar's Nest Springs and Seminole, the groundwater in the shallow alluvium becomes much more mineralized. This is the result of concentration of the minerals by evapotranspiration when the water table was at the surface, and of the addition of mineralized irrigation return flows.

Cedar Lake or *Laguna Sabinas* in northeastern Gaines County was once surrounded and fed by numerous fresh and slightly saline springs, some moderately large, flowing chiefly from sand on top of limestone. Clovis projectile points and other artifacts indicate that at least 15,000 years ago this was a favorite haunt of Paleo-Indians. Later their successors, the Apaches and Comanches, camped at the springs. Cynthia Ann Parker lived here during much of her sojourn with the Comanches from 1836 to 1860. And here her son Quanah Parker, a well-known Comanche chief, was born. The area teemed with wildlife of all kinds. The end of this long era of living in harmony with nature came in 1875, when Col. William Shafter attacked the Comanches here, destroyed their horses, mules, food, and hides, and forced them to enter a reservation in Oklahoma.

Since that time white settlers have done an efficient job of destroying the land, groundwater, springs, and most of the natural plant and animal life that flourished at Cedar Lake. According to R. B. Jones of Plains, who formerly owned this land, in 1910 **Buffalo Springs (1)** on the north side of the lake produced a stream 1.1 meters wide and knee deep. In 1963 there was still a very small flow (0.006 liter per second). **Johnson Springs (11)** on the south side of the lake still produced 0.06 liter per second in 1963. Other springs (3) existed at Roy Medlin's ranch on the west side, and on the northeast side. None of the **Cedar Lake Springs** were flowing in 1977, although some showed pools of standing water.

The former lake is now just an alkali flat from which Ozark-Mahoning Company mines sodium sulphate. On March 17, 1977, it could hardly be seen because of a vicious dust storm. The flat is now surrounded by sage, blackbrush, mesquite, shinnery oak, and yucca. A historical marker is present on the highway to the northeast.

On McKenzie Draw south of Cedar Lake are the largest springs still flowing in the county, **Balch Springs (5)**. They are located at latitude 32°44' and longitude 102°18'. On March 18, 1977, they were yielding 2.5 lps from caliche at an elevation of 945 meters above sea level. The moderately saline water flows into a stock tank containing large catfish. Downstream is about one hectare of standing water covered

Site of former Buffalo Springs at Cedar Lake.

with rushes and salt cedar, with a heavy deposit of salts upon the soils and grasses. (See Plate 4, c). Ducks and geese winter here.

About three kilometers upstream on Katy Whitaker's farm are a number of seeps along McKenzie Draw (4). Here are several hectares of seepy land, with some standing water. According to Jim Faulkenbery, who rents this land, many Indian artifacts and middens have been found on the bluffs along the draw.

At McKenzie Lake, 31 kilometers east of Seminole on Highway 180, there were still moderately large springs (7) at the northwest and southwest ends in the 1920s, according to J. V. "Blondie" Barnett. On March 18, 1977, they were no longer flowing, but contained some standing water, and the lake was dry.

Two kilometers south of the junction of Highways 180 and 303 east of Seminole is a former lake bed, still marked by dark organic soils. Raymond and Fern Golden, the owners, say that since 1929 there has been no water in the lake except for storm runoff. The lake was evidently fed by seeps (2) from the surrounding sand and caliche before groundwater tables declined. Many projectile points, metates, manos, and hearths have been found here, pointing to long use of the spot as a campsite. The Indians probably dug shallow wells near the lake to obtain water. In 1977 the water table was 20 meters below the surface.

Nine kilometers south of Seminole, on Seminole Draw, there were about 20 **Indian Wells (9)**, where seeps issued from Ogallala sand. Here and at Hackberry Grove Apaches and Comanches, and later Seminoles too, met, traded, and dug shallow wells.

Downstream on Seminole Draw, at latitude 32°39' and longitude 102°30', springs (6) formerly flowed on the Edwin Castleberry ranch. According to Mrs. Castleberry, they have not flowed since 1925 at least. A windmill at the site probably hastened the springs' disappearance. An Indian camp was located one kilometer southeast. Many artifacts and middens found along this stretch signify that there was a reliable water supply here in the past.

There were probably also seeps along Monument Draw in the southwestern corner of the county. Along this draw ran an important Apache trail from Monument Springs south of Hobbs to Big Spring.

Four kilometers south of Seminole near a historical marker on Highway 385, is Hackberry Grove. Here in 1875 a Lt. Ward found about 50 shallow wells 1.2 to 4.5 meters deep and containing 0.6 to 1.2 meters of water. They were probably dug by the Comanches in seepy areas (8). Lt. Col. W. R. Shafter in 1875 described the water as of "excellent quality," with excellent grass. As recently as 1905 water could be dipped by hand from the shallow **Ward's Well** nearby. This was a rendezvous for Indians, explorers, Comancheros, and horse hunters. In later years many camp meetings and picnics were held here. Now the water table is at least 10 meters below the surface, and the old Indian wells have all been filled with drifting sand and flood-borne sediment. The Hackberry Grove may still be seen, however.

GALVESTON COUNTY

The barrier islands of Galveston County began to form about 18,000 years ago as the sea level rose to within 5 to 7 meters of its present elevation because of the melting of the last continental ice sheets of the glacial period. Since then the islands have constantly changed, especially while being pounded by hurricanes. For example, *Culebra* (Snake) Island at the eastern end of Galveston Island was in historic times a separate island, but was later joined to Galveston Island. Pelican and Deer Islands did not exist prior to 1815.

In this constant state of flux it is surprising that any evidence of prehistoric inhabitants or the seeps that they used can be found. Nevertheless sites containing prehistoric artifacts have been discovered, including one on Bolivar Peninsula which was occupied as early as 1,500 years ago. These early inhabitants were the ancestors of the Karankawa Indians, a tall, comely people who were friendly to the whites until their friendship was abused. They used 2-meter-long bows which very few white men could string. They knew that in this coastal area the best drinking water flowed from seeps on the bay side of the higher barrier-island deposits. When the seeps did not flow freely they dug holes at these sites to obtain fresh water. They must also have known that many of the seep-fed lakes behind the coastal dunes contained fresh water, except after hurricanes. The water in the bay behind Galveston Island was usually too saline for human consumption.

In 1497 Amerigo Vespucci is thought to have mapped this coast, and perhaps stopped to obtain water from the seeps or fresh-water lakes. And in 1528, although there is still considerable doubt as to his route, Cabeza de Vaca and his company were probably shipwrecked on Galveston Island (which he called *Malhado*, or *Misfortune*, Island). they visited a Karankawa village and probably drank from the island's springs and seeps.

Galveston was first settled permanently in 1816, when Louis-Michel Aury and Francisco Xavier Mina set

up headquarters there. The following year they were joined by Jean Lafitte. At that time and until at least 1866 two small springs **(Galveston Springs, 1)** running from the back of the sand hills provided most of the drinking water for the town (Dyer, 1916). Dyer could not find them in 1916, and they are certainly gone now. The hills from which they flowed have largely been destroyed by hurricanes and leveled by urban and seawall construction. In addition, after the disastrous hurricane of 1900 the level of the entire town was raised by depositing dredged material. This operation may well have destroyed Galveston Springs.

In 1835 J. C. Duval noted that, while cruising on a steamship off the east end of Galveston Island, a boat was sent ashore to obtain wood and water. He remarked that slightly brackish water could be obtained by digging at the base of the sand hills. In 1836 when Mexican prisoners were camped on Galveston Island after their defeat at San Jacinto, one of them stated:

> We obtained water from holes dug on the bay shore. It was warm, and tasted horridly.

In 1840 another traveler remarked

> Water of rather indifferent quality, but just admissible for culinary purposes, may be obtained by digging a few feet in any part of the island.

In 1857 tanks were sunk in the streets of Galveston to obtain a supply of water for fire fighting. These provided breeding places for mosquitoes and probably contributed to the yellow fever plagues. Nevertheless insufficient water was available to fight the great fire of 1885, when 40 blocks were destroyed. In 1888 several wells were drilled on the mainland, and a modern water system was started.

The county's spring waters are mostly of a sodium chloride or bicarbonate type, fresh or slightly saline, and hard. Most of the writer's field studies were made on August 26 - 31, 1975.

In early historic times a Karankawa village was located back of Jamaica Beach, 21 kilometers southwest of Galveston. A historical marker commemorates the site. It was also known as *Three Trees* to mariners, who could distinguish three clumps of live oaks from the sea. The village was on a ridge 3 to 4 meters above the surrounding marshes, and "relatively free" from cottonmouth snakes. The Karankawas beat the grass before them with long sticks and fired the grass around their camp to drive away the snakes. The seeps (3) nearby were vital to the Indians. They now drain into a lake which has been "developed" into a network of boat channels. The water tastes slightly saline.

Seeps at former Karankawa village.

Lafitte Seeps (10) are about 18 kilometers southwest of Galveston on Stewart Road. Lafitte's Grove, a campsite used by the buccaneers, was adjacent. Near here some of Lafitte's men caught and raped an Indian woman, an act which did not improve relations with the Karankawas. The seeps now drain into Lake Como. Flowing from fine sand, the water tastes slightly saline.

Sweetwater Lake, 12 kilometers west of Galveston, was at one time considered as a source of water for the town, but the plans were never implemented. It is fed by two groups of very small springs (2) which flow from sand in the back of barrier-island deposits. The water, which flowed 0.13 liter per second in 1975, tastes fresh, but probably becomes saline after hurricanes.

Seeps (4) also existed at Fort Travis, two kilometers southeast of Port Bolivar. They were probably used by the Spanish in the Fort's earliest days (1816 - 17) before wells were dug. Possibly they were dug out as shallow holes, as the Indians often did. A historical marker on Highway 87 commemorates the fort. In 1821 a heroic woman, Jane Long, waited in vain for her husband here, firing a cannon to scare off the Karankawas. She also likely made use of the seeps.

Around the northwest side of the High Island salt dome on Bolivar Peninsula, at latitude 29°34' and longitude 94°24', are the **Smith Springs (5 - 9)**, which flow from fine sand of the Beaumont formation. They were ably described by Mrs. M. S. Helm (1884) in telling of her 1836 trip by land from Beaumont to Galveston, as follows:

> The next day we got an early start and got to the half-way station, where there are two mounds, so unlike anything I ever saw on the coast, it caused profound admiration and wonder. They occupied together with the valleys between, some acres,

with both salt and fresh springs. A house on each mound, the top probably one hundred feet above the level of the Gulf. Signs of salt boiling and occupancy of workmen, were evident.

Five springs flow from the north and west sides of the dome. The second and third from the north were studied by Deussen in 1914. All flow fresh water except the second from the north (6) which is slightly saline. This salinity may be caused by the salt plug which underlies the dome. Most of the springs are surrounded by large Spanish and live oaks, cedar, pecan, gum, and hackberry trees. Moving from north to west, the first spring (5), now only a seep, supplies Smith Pond. (See Plate 4, d). Springs 6, 7, and 8 flowed 0.02, 0.30, and 1.0 liter per second in 1975. **Abadie Spring (9)**, discharged 0.13 lps. The flows have been greatly reduced by heavy water-well pumping in the vicinity.

GARZA COUNTY

The western edge of Garza County lies on the High Plains or *Llano Estacado* (Palisaded or Stockaded Plains). Around the eastern edge of these plains, springs flow or did flow from Tertiary sand, gravel, and caliche. Most of the county lies at lower elevations on the Red Bed or Gypsum Plains. Here some springs issue from Quaternary sand, gravel, and caliche, and from Triassic Dockum sandstone. Often the springs appear on top of the underlying Triassic shale and clay. The scenic red rock canyons below the caprock of the High Plains provide a beautiful setting.

The springs were undoubtedly used by early man many thousands of years ago. Later the Lipan Apaches lived at the springs, until the mid-1700s when they were driven out by the Comanches. In the nineteenth century large Comanche villages existed at the springs in canyons below the caprock.

Droughts in 1917 - 18 and 1933 - 34 caused many springs to dry up temporarily. Pumping of groundwater for irrigation began to take a severe toll after the 1930s, but other causes also contributed to the decline of groundwater tables. As a result many springs have weakened or failed.

Severe gully erosion along the breaks of the High Plains and in Triassic clays has filled many stream channels and buried springs. As the springs have dried up or been covered up, many plants and animals which depended upon the water have disappeared.

The spring waters are normally of a calcium bicarbonate type, fresh, very hard, and alkaline. The fluoride, iron, and silica contents may be high. Contamination by oil-field brines has occurred in the past, affecting some springs.

Most of the writer's field studies were made during the period June 1 - 6, 1979. As about 10 centimeters of rain fell during this time, the observed spring discharges are probably larger than normal for this season.

Five kilometers west of Post were **Post Springs (12)**, on Rex Allison's ranch. In 1907, when Post was first organized, the water from these springs was piped to the town. But as they did not supply half the water needed, wells were soon drilled on the plains above. The springs, long dry, trickled from Ogallala sand. They were near the old concrete city reservoirs which are now beneath tennis courts. One of the reservoirs has been made into a game room.

At the municipal golf course five kilometers northwest of Post, the **Golf Course Springs (3)** also flowed formerly. Many Indian artifacts have been found here. According to D. H. Bartlett, who manages the golf course, the springs were strong in the 1930s, when boys swam in the holes downstream. The discharge ran two kilometers down the creek. Some seepage continued until 1975.

About one kilometer north of Golf Course Springs were similar ones on A. C. Cash's land, leased by George Miller. Their water was formerly piped to a trough. When they dried up in the 1930s, they were cleaned out and dynamited, but to no avail.

Tipton Springs (4) were seven kilometers northwest of Post on J. D. Tipton's ranch. Around 1929 Tipton swam as a boy in a large hole filled with the spring water below a sandstone ledge. The springs have been dry since about 1945, and the swimming hole is now largely filled with sand. Salt cedar, cedar, mesquite, hackberry, and chinaberry trees cover the site.

Barnum Springs (6) were 12 kilometers north-northwest of Post on Marian Lee Minor's property. The Barnum Springs school once used the water, which flowed from Triassic sandstone. The water formerly ran for a distance down the draw, according to neighbor John Bland. He believes it was contaminated by oil-field brines in about 1971. Live water existed in holes until around 1975, but they are now dry. A windmill pumps near the old school site. Willow and hackberry trees and cockleburs and dock cover the place.

Double U Springs (5) are six kilometers southeast of Southland on C. E. Basinger's ranch. This was formerly the Double U ranch. The fresh water issues from Ogallala sand on top of a massive Triassic sandstone and falls about eight meters into a beautiful swimming hole. On June 3, 1979, the discharge was 0.28 liter per second. Bullfrogs croak among the rushes, shaded by cottonwood and willow trees. Coyote tracks

may be seen. The springs give rise to North Dokegood Creek. Similar springs come out on South Dokegood Creek five kilometers south-southeast.

Five kilometers northeast of Southland are **Whiskey Springs (7)** on the Sand Creek ranch. W. V. Boreing is caretaker of the ranch, where a number of Lubbock residents have weekend cottages. These are probably the springs where Tom Askins and his family settled in 1888, sinking a barrel in the sand to collect the water. Later, during the Prohibition era, a whiskey still used the water. It seeps from Ogallala sand onto a ledge of Triassic sandstone, from which it drops eight meters into a pool. On June 3, 1979, 0.05 lps dripped over the rim. Frogs chirped among the rushes, shaded by hackberry and chinaberry trees.

A similar spring on the Sand Creek ranch is in Red Hollow two kilometers south-southwest. The flow here was 0.07 lps on June 3, 1979. A footbridge has been built across the deep valley trench, eroded in modern times. Cottonwoods and willows grow here. Much wildlife frequents the area, including gray foxes, raccoons, opossums, bobcats, and hawks.

About 13 kilometers north of Post on the northeast side of the Brazos River were **Llano Springs (8)** on Avery and Zelma Moore's ranch. Here the Llano Cattle Company in 1879 established a dugout headquarters, which was soon raided by Indians. According to Moore, the many springs flowed until the 1940s. Issuing from Triassic sandstone on shale, seeps still occur in wet weather.

Ten kilometers southwest of Kalgary is the Lane archeological site on A. C. Cash's farm. Here on McDonald Creek a Neo-American people lived, perhaps as long as 1,000 years ago. **Lane Springs (14)** were nearby. The tusk of a mammoth which may have bogged down in the springs was found here. Now there are only wet-weather seeps from Quaternary sand on Triassic clay. Salt cedars, willows, and plum thickets adorn the site. Shinnery oak and sand sage cover the ridges.

Nine kilometers south-southeast of Kalgary are **Indian Springs (18)** on the Chimney Creek ranch, owned by the H. C. Lewis estate and managed by Larry Bownds. The water trickles from Quaternary sand and gravel on Triassic sandstone and conglomerate, which contains petrified wood and quartz crystals. On August 31, 1979, 0.12 lps of water fell over the rock ledges. Here the Indians once obtained yellow ochre paint for themselves and their horses, according to Bownds. A trading post was later located at the springs.

Much wild life is present. Scissor-tailed flycatchers dart among the salt cedars and vauquel bushes. Raccoon tracks can be seen among the cattails. Frogs croak in the pools. The similar **Chimney Springs** are 0.8 kilometer upstream.

K Springs (19) are six kilometers east-southeast of Indian Springs, also on the Chimney Creek ranch. The remains of an old dugout are nearby. A woman who died after being bitten by a skunk was buried here.

Southeast of Lane Springs, at latitude 33°17' and longitude 101°10', were some springs (16) on Arnold Sanderson's ranch. They were shown on a 1969 U. S. Geological Survey topographic map, but on June 5, 1979, only seeps were present. The springs issued from a massive mossy Triassic sandstone, in which water stands in tinajas for a time after rains. Nearby, Indian petroglyphs have been reported in a small rock shelter. The seepage helps feed several reservoirs. Killdeers fly among the willows and algeritas.

Four kilometers farther south were **Slicknasty** or **Slick Nesty Springs (20)**. Issuing from Triassic sandstone, they also are now only seeps. They were formerly an important watering place on the Spur ranch.

Fifteen kilometers east of Post, south of the North Fork Double Mountain Fork Brazos River, were **OS Springs (15)**, on Giles Dalby's ranch. Nearby are some petroglyphs carved in the rock by prehistoric residents. In 1832 near here Albert Pike found water standing in holes. "His animals drank in a miry branch," according to Haley (1969). The OS ranch headquarters were located here in 1889. In 1906 a picnic was held in the chinaberry grove here, at which the organization of the county was planned. OS Springs trickled from jointed Dockum sandstone. Now they are only wet-weather seeps. Several other springs once flowed on the ranch.

Eight kilometers east of Justiceburg were **Reed Springs (17)**, on Weldon Reed's ranch. Here John and Martha Reed obtained water and washed in 1905. Nearby are some boat-shaped mortars ground into the sandstone by an ancient people. On June 5, 1979, there was only a seep in the massive Dockum sandstone. The soft rock has been moulded into bizarre shapes by running water, and several names have been carved into it. Salt cedars, willows, and algeritas thrive here. An abandoned oil well is close by.

Rocky Springs (1) are nine kilometers east-southeast of Justiceburg on Mrs. John Blakey's ranch, leased by Walter Boren. Issuing from massive Dockum sandstone bluffs, the slightly saline springs feed Rocky Creek, which usually runs three kilometers to Double Mountain Fork Brazos River. Raccoon and coyote tracks are numerous among the rushes and seep wil-

lows. Cedar trees cover the adjacent hills. Petroglyphs have been carved in the rock near the mouth of the creek. Little Grape and Grape Creeks to the east are also spring-fed.

On Highway 669 close to the Borden County line is the Garza archeological site, on Jack Lott's U Lazy S ranch. Here on Sand Creek lived the Garza people before 1500 A.D. A historical marker designates the site. These early residents undoubtedly made good use of **Garza Springs (2)** some of which still trickle in wet weather from massive Dockum sandstone on clay. On June 2, 1979, the fresh water seeped into a draw (greatly enlarged by modern gully erosion) north of Sand Creek and west of the highway. The water barely ran a short distance down the draw. Raccoon tracks meander among the rushes, salt cedars, willows, and purple horsemint. A few other seeps occur in winter on the U Lazy S ranch, but no longer supply reliable water for cattle.

Spring Creek Springs (13) are located about seven kilometers southeast of Grassland on Bob Macy's ranch. Issuing from Ogallala sand on Triassic sandstone, they feed Spring Creek. Many Indian artifacts have been found here. In winter and early spring the springs, in about seven groups, produce about 2.2 lps, which run 4 kilometers and cross the county road, according to Macy. In summer the flow is less, running about 1.6 kilometers. Many swallows build mud nests in the cliffs among willow trees.

Cooper Springs (9) are in Cooper's Canyon seven kilometers south of Post on Gladys Gates McClure's ranch, leased by James Stone. The water appears from Ogallala sand on top of a very hard layer of Triassic sandstone, falling 20 meters into several pools below. The springs were on a cattle-drive trail in the late 1800s. A post office and store in a dugout were nearby. The gorge below the falls, called "the cave," was a favorite picnic and swimming spot in the early 1900s. Many names have been carved in the soft sandstone.

Cooper Springs were formerly quite strong. On June 4, 1979, 0.72 lps of fresh water poured over the waterfalls, running about one kilometer before disappearing. Clouds of swallows fly about their nests in the cliffs, which are adorned by maidenhair ferns. (See Plate 9, d). The lush vegetation includes cottonwood, willow, large cedar, and salt cedar trees, grapevines, and rushes. Frogs and water striders dart in the pools.

Boy Scout Springs (10) were four kilometers southwest of Post in the Boy Scout camp. They were used by the Llano or Curry Comb ranch in the early 1880s. In 1883 the first well in the county was dug nearby. Marked by a historical plaque, it is now dry. A

Erosion-carved sandstone at Reed Springs.

natural road from the springs up over the caprock was much used by buffalo and Indians, as well as the later settlers.

According to Frank "Chief" Runkles, who was in charge of the Boy Scout camp for many years, the springs supplied water to the camp from 1925 to 1946. In 1925 they flowed about two kilometers down the creek. Soon after 1946 they stopped flowing. There are still wet-weather seeps, but the channel has been largely filled with sand. Cottonwood and willow trees and grapevines are numerous.

Box Canyon Springs (11) are four kilometers west-southwest of Post on Sonny Gossett's ranch. They lie in the deep Box Canyon at the edge of the High Plains, edged with caliche caprock cliffs. In an old lake bed just above the caprock, according to Chief Runkles, have been found mammoth remains and Paleo-Indian artifacts. On June 4, 1979, the discharge was 0.83 lps. Many swallows nest in the cliffs. Cottonwood and willow trees and rushes grow luxuriantly here.

GRAY COUNTY

Most of the springs in Gray County issue from Tertiary Ogallala sand and gravel which slopes toward the major rivers and streams. This formation is up to 210 meters thick, most of it formerly saturated with groundwater. The water moves through the Ogallala at around 100 meters per year. Springs are most apt to be found where the Ogallala rests upon an outcrop of relatively impervious Permian Quartermaster shale, siltstone, or dolomite. They flow chiefly in the "breaks" which drain into the North Fork of the Red River and McClellan Creek in the eastern part of the county, and formerly along Red Deer Creek in the north.

The county's springs have been favored campsites for 15,000 years or more, beginning with the mammoth-hunting Paleo-Indians. Most of the streams, fed by springs, flowed constantly. Many of the larger

lakes on the plains were also spring-fed and contained a reliable supply of fresh water.

The springs are often surrounded by bogs containing rushes, cattails, and arrowhead plants. Fringing the bogs are usually found cottonwood, willow, and hackberry trees, grapevines, and plum thickets. Deer, antelope, turkeys, ducks, geese, raccoons, beavers, snakes, turtles, fish, and many other wildlife types depend upon the environment of the springs for their lives. But many of the animals and plants of this complex ecosystem are now gone. Wolves, bears, buffalo, and prairie chickens are extinct in this area.

Irrigation pumping has greatly damaged the groundwater reservoir. The water is being removed much faster than it can be replaced by natural recharge from rainfall and infiltration from lakes and streams. In addition, oil and gas well drilling, repressuring of oil fields, and cooling for petroleum products plants and pumping stations have consumed large quantities of groundwater. As a result, the water table is falling. During the period 1954-63 the decline was as much as 1.0 meter. The downward trend has accelerated in recent years. As a result, many springs are drying up.

Severe erosion in the past has left scars in the form of partially healed gullies. Sediment from these gullies has choked many stream channels and buried some springs.

The water is generally of a calcium bicarbonate type, fresh, alkaline, and very hard. The content of silica or fluoride may be high. Contamination of groundwater by oil-field activities, especially open-pit disposal of brines in the past, has been serious.

Most of the writer's field studies were made during the period July 11 - 16, 1978.

Three kilometers west-southwest of Hoover were **Red Deer Springs (20)**, the source of Red Deer Creek. According to owner Hobart Fatheree they have been dry since at least 1928, but the creek is now fed by sewage from Pampa. In 1845 Lt. James Abert and his mule train camped here. He described the site as follows:

> We reached Elk creek about 2 o'clock, but by following the directions given us had struck it too high, and there was no water. Beyond, we were sure it was not to be obtained, and therefore commenced to descend, looking anxiously along its sandy bed in search of the desired element. After following the sandy route about two miles, we found a sufficient supply, with a fine site for our camp, on a high tongue of land deeply indented with buffalo paths, between the junction of the forks. Here we observed great numbers of the night-hawk, "caprimulgus Americanus," which were darting around us in all directions, frequently passing within our reach, while the plover, "charadrium vociferous," along the bed of the stream, was ever and anon sending up his lone melancholy cry of "killdeer."

At Snowden Lake six kilometers west of Laketon were **Snowden Springs (19)**, at Buddy Cockrell's feedlot. The bubbling springs were south of the center of the lake. The Indians considered them to be sacred, and held dances and celebrations here at certain periods of the moon. They bathed in the springs to heal their wounds and make them brave. In 1888 John and Nancy Paris built a cabin here. After 1905 the springs dried up. On July 14, 1978, in spite of much rain during the preceding several months, the lake was almost dry. Its bed is now irrigated and farmed.

Stump Springs (18) were four kilometers east of Laketon on Elmer McLaughlin's ranch. Near the cottonwood tree at these springs John Stump built a dugout in 1890. Many neighbors obtained water here. The dugout pit is still visible in Ogallala caliche and the old cottonwood still lives. But the springs are quite dry.

Cabin Springs (2) were on Roy Sawyer's ranch five kilometers northeast of Lefors. This is probably the place described by Lt. James Abert in 1845 as follows:

> We now crossed to the left bank of the creek, and encamped in a delightful nook shaded by tall cotton-woods, and affording plenty of grass, and where we stopped to refresh our weary animals and receive the visits of the village, which was near. Old men, squaws, and children soon flocked around us, eagerly offering to trade, and appeared much dissatisfied because we had nothing to exchange with them; for they had expected to obtain some memorial of the coming of the "Tab-bi-boo," or Americans, which to them is a great gala day; and they care little if they pay double the value of an article, provided they have something to show and to say when the village gossip commences.

The springs are now dry, and severe erosion has filled the Cabin Creek channel with sand. Some cottonwood trees and plum bushes still fringe the creek. Many oil wells pump nearby.

Cantonment Springs (16) are on West Cantonment Creek nine kilometers south of Laketon on Joe and James Franklin's ranch. The place was described by Capt. Marcy in 1854:

> Making an early start this morning, we travelled eleven miles in a westerly course, when we reached a very beautiful stream of good spring water, flowing with a uniformly rapid current through a valley about a mile wide, covered with excellent grass. There is a heavy growth of young cotton-wood trees along the borders of the creek, and among them I found immense quantities of that peculiar variety of grape [wild plum] I have before mentioned as growing in the sandhills along the valley of Red river. They grow here upon low bushes about four feet high, similar to those cultivated varieties that are trimmed and cut down in the spring. When growing near the trees they never rest upon them, like our eastern varieties of the wild grape, but stand separate and erect, like a currant-bush.

In 1875 there was an Army camp or cantonment here. On July 14, 1978, 1.7 liters per second issued from seeps in Ogallala sand on top of Permian shales, coursing two kilometers downstream. A large wood of cottonwoods, walnuts, and black locusts surrounds the springs, where rushes and pondweeds grow. Minnows dart in the pools, and turkeys are numerous. Near its mouth Cantonment Creek is completely filled with sand, and no spring flow reaches this far.

Gething Springs (17) are 10 kilometers south-southeast of Laketon on East Cantonment Creek on the W. D. Gething ranch. The largest in the county, they produced 7.1 lps on July 14, 1978, of which 4.2 was lost to evaporation in a downstream chain of lakes having a surface area of 10 hectares. Rising at an elevation of 815 meters, the water runs about three kilometers before disappearing. Mr. Gething remembers when the springs originated about one kilometer farther upstream. Areas of black, former swamp, soils disclose that there were once many more and larger springs in the surrounding hills. Turkeys, blue herons, and rare trumpeter swans frequent the spring-fed lakes. The lakes and springs are protected by a flood-water bypass. Picnic tables and barbecue grills are situated in a private wooded park.

White Horse Springs (6) are 13 kilometers southeast of Laketon on Gene Hall's ranch. Named for a white stallion which was caught here, they were shown on maps of the 1870s. When Charles Webb lived at the nearby house in 1912, he carried water from the springs. Formerly issuing partly in a spring box, they feed Huselby Creek. On July 12, 1978, 2.1 lps trickled from Ogallala sand amid a thick tangle of vines and poison ivy, with much water cress. The water frequently disappears and reappears in a thick mat of organic debris. Black snakes may be seen here.

About one kilometer west of Lefors in the channel of the North fork Red River are **Lefors Springs (9)**. On July 13, 1978, they produced 6.5 lps which coursed downstream two kilometers before disappearing. According to Arlie Carpenter of Lefors, the water reappears at various points downstream and in winter flows considerably farther. Captain Marcy is believed to have stopped here in 1852. The water contains 2,000 milligrams of chloride per liter. According to owner Raymond McPherson, it was contaminated by oil-field operations. Minnows play in pools shaded by Russian olive trees.

Thirteen kilometers east of Lefors in a terrace of sand and gravel on the north side of the North Fork Red River are **Big Springs (10)**. They are on John Haynes' ranch. They were used by the large nearby village of

W. D. Gething at Gething Springs.

Kwahadi or Kotsoteka Comanches. In 1872 the "bold and daring" General Mackenzie, with a force greatly outnumbering the Indians, massacred the residents of the village, including many women and children. On July 13, 1978, 1.0 lps gurgled from a caving gully in the terrace. The North Fork was dry here. In winter the springs flow to the river. A thick growth of rushes, water parsnips, and arrowhead plants surrounds them. The springs feed a pond filled with milfoil and containing fish and turtles. The surrounding dunes are covered with shinnery and millions of sand burs.

Across the North Fork Red River and three kilometers southeast are **Jewel Springs (5)**. These springs also were used by the Comanche village just northwest. Now there is a pool of live water containing milfoil, but no overflow. Frogs and dragon flies cavort in the shade of willow trees.

Farther east on the Haynes ranch and two kilometers south of the Highway 1321 bridge over the North Fork were **Stage Hollow Springs (4)**. Many artifacts found here reveal that this was a living site of Indians. Much later it became a stage stop on the Clarendon-Mobeetie run. The springs are now dry and Stage Hollow Creek is choked with sand. Cottonwoods and willows still shade the site.

Twelve kilometers north of McLean on John Carpenter's ranch is **Indian Spring (13)**. Here Indian burials and a pipe of the Panhandle culture were found. The spring was depicted on L. H. Orleman's 1874 *Map of Fort Sill Indian Territory*. Now it produces only 0.03 lps which flows through a pipe and steel tank 50 meters down the slope to a button bush. Milton Carpenter, John's father, recalls that Indian George, who formerly worked on the ranch, would drink no other water but that from Indian Spring.

About one kilometer northeast of Indian Spring there were formerly other springs, about which Milton

Carpenter wrote in the Spring 1977 issue of the Gray County Soil and Water Conservation District News:

> I will be seventy-one years old April 2, 1977. I was born in Wheeler County and moved to Gray County in April, 1913. Where I lived there were two spring branches running nice streams of water on each side of the house. The streams were about fifty yards from the house, one on the north side and one on the south side. The south spring stopped running about the first of August and then started again in November. The north spring ran all summer. There was a nice rock spring milk house on the north side between the house and the spring branch. Milk was kept in this during summer days to keep it cool. The south branch stopped running even during the winter in 1918. The north spring stopped running in 1923.

Another spring (11) is located three kilometers east-northeast of Indian Spring, across McClellan Creek. This spring once filled a 2-inch pipe (about 1.3 lps), according to Carpenter. Many cattle formerly bogged down in the soft sediment around the spring. Now there is only seepage in the rushes where frogs live, surrounded by button bushes.

Eight kilometers north-northeast of McLean are **Hackberry Springs (12)**, on Richard Back's ranch. These springs also were portrayed on Orleman's 1874 map. On July 13, 1978, 6.1 lps issued from Ogallala sand, flowing 500 meters and supplying two ponds on Milton Carpenter's ranch. In winter the water runs to McClellan Creek. In many deep holes along Hackberry Creek fish and beavers thrive among the milfoil, pondweed, and arrowhead plants while red-winged blackbirds squeal overhead. This is one of the few creeks in the county which still retain something of their original beauty. But a large hillside field upstream has been plowed, and Carpenter worries that a heavy rain could wash enough sand into Hackberry Creek to bury it forever.

On the H. H. Hudgins ranch 12 kilometers northwest of McLean are **Clear Springs (15)**. These springs also were shown on Orleman's 1874 and Gillespie's 1875 maps. In about 1902 Mr. Hudgins' grandfather dug a ditch from the springs to a pear orchard two kilometers downstream and used the water to irrigate the trees. The discharge must have been at least 6.5 lps at that time. On July 14, 1978, 2.7 lps trickled from Ogallala sand on Permian shale, running about one kilometer through a soft boggy area before disappearing. The bog is filled with rushes, arrowhead plants, water parsnips, and water cress. Dragon flies and killdeers dart over the pools where minnows swim.

In 1891 Alanreed was known as Spring Tank or Springtown. This was because of the spring-fed earth tank (14) which existed just to the northeast. The springs provided water for the settlement, and the tank was much used for baptizing and swimming. Because the springs were located relatively high on the hillside (915 meters elevation), they died early in the fight against the advance of "civilization." The dam has also been washed out, but a few trees remain at the site.

McClellan Springs (8) trickle just downstream from Lake McClellan. Indians were evicted from their home here in a battle in 1874. The water issues from Ogallala sand surrounding an inlier of Permian shale. On July 11, 1978, the discharge of 1.0 lps ran almost to the road crossing six kilometers downstream. The springs are fed partly by seepage from Lake McClellan. According to Charles King, manager of the Lake McClellan concession, some small springs flowed upstream from the lake until about 1975. Beavers and minnows are active in the duckweed-covered pools.

In 1890 John Harris and his family, living at Jericho, hauled water from a spring (7) on McClellan Creek just upstream from present McClellan Lake. The site is now on the W. A. Bralley ranch. The spring has long ceased flowing, but some damp spots still exist in the creek bank here. The site is in a dense grove of cottonwood, hackberry, walnut, and chinaberry trees.

A second **Big Springs (21)** was located on the headwaters of the North Fork Red River, 13 kilometers south of Pampa. The site is on Mrs. John Bowers' ranch. A Kiowa village here used the water. In 1879 Captain J. A. Wilcox depicted the springs on his *Map of a scout made by Companies C and H, 4th U. S. Cavalry*. They have been dry since at least 1928. Many oil wells pump nearby. Severe gully erosion has filled the stream channels with sand. A few cottonwood trees still survive.

GRAYSON COUNTY

The springs of Grayson County are located chiefly in the northeast portion, flowing mainly from Woodbine sand, Austin chalk, and river terrace sand and gravel. Water tables have declined greatly, largely because of heavy well pumping. In the Woodbine sand, for example, water levels declined 48 meters between 1945 and 1958. Before the construction of Lake Texoma in 1943 there were numerous springs along the Red River. Now the lake recharges the groundwater aquifers, especially the Trinity sand, and groundwater movement is away from, rather than toward the river. Water levels in the other aquifers continue to decline, and many springs have been allowed to fail in the name of *progress*.

In prehistoric times the abundant and numerous springs along the Red River and its tributaries were occupied for many thousands of years by the

Tonkawas and earlier Americans. More recently the Comanches and Wichitas made this their home. Finally, in the 1830s, for a brief period before they were forced out by the white settlers, various tribes which had been previously evicted from their lands in the southeast lived at these beautiful springs. These included the Delawares in the northwest part of the county, the Shawnees at the mouth of Shawnee Creek north of Denison, and the Choctaws, Creeks, Chickasaws, and Cherokees.

Raccoons, coyotes, and bobcats depend heavily upon the springs' environment for their water and food. Regrettably, fur buyers are encouraging landowners to kill these animals. Bobcat pelts bring $120 and coyote pelts $30.

Some springs now under the waters of Lake Texoma were very important to the early settlers. There were, for example, **Sand Springs** at Coffee's 1839 trading house near the mouth of Little Mineral Creek. During the Civil War Glauber's salt (sodium sulfate) and copperas (iron sulfate) were produced from some of the county's spring waters. The community of Red Branch in Northwestern Grayson County was named for the red, iron-bearing water of this area.

The water is generally of a calcium bicarbonate or sulfate type, fresh, moderately hard to hard, and of neutral pH. The iron content is often high, especially in the Woodbine sand. The county's springs were studied by the writer chiefly during the period December 20 - 25, 1976.

Odneal or **Big Springs (1)** are located near the intersection of Odneal and Branch Streets in Sherman and for about 300 meters upstream from this point. In 1848 Sherman was moved from its location six kilometers west to these springs because of their abundant supply of pure water. In 1858 the Butterfield Overland stagecoaches stopped here. The springs still (1976) yield about 1.5 liters per second from Austin chalk.

Five kilometers northwest of Sherman are **Post Oak Springs (5)**, which give rise to Post Oak Creek. According to Lucas and Hall (1936), the Indians had a camp here. Beaver dams may still be seen below the springs. They flowed only 0.05 lps in 1976 from the Eagle Ford shale.

Five kilometers north of Sadler, on Edith Funk's farm, are **Basin Springs (19)**. They were very important to early residents, and were shown on Hedgcoxe's 1852 and Livermore's 1883 maps. An academy was located here from 1872 to 1879. Located 400 meters northeast of the Basin Springs cemetery, they poured 0.18 lps of water into a moss-covered basin of Woodbine sandstone in 1976. Bobcats and raccoons depend on this and another smaller spring one kilometer east near the church.

Brogdon Springs (17) are seven kilometers northwest of Pottsboro. A marker reminds that a distinguished regiment in Ross' Texas Brigade was organized here in 1861. According to Neal Henderson, who lives nearby, a fort existed here at one time. The springs were called **Martin Springs** on some later maps, including Granger's (1878), Livermore's (1883), and Rand McNally's (1883). About 0.60 lps still flows from Woodbine sand.

Approximately 400 meters east are the similar **Stout Springs**. As Lucas and Hall state,

> Clear cold water still flows from the rocks as it did during the days when Capt. Stout and his rangers made camp here [in 1839].

About 0.55 lps still issued in 1976 from a cliff of Woodbine sandstone in which have been carved many names and dates. Bobcats are numerous here. A pot of coins is said to have been found at the springs. Downstream is a waterfall which includes the springflow of Brogdon Springs also.

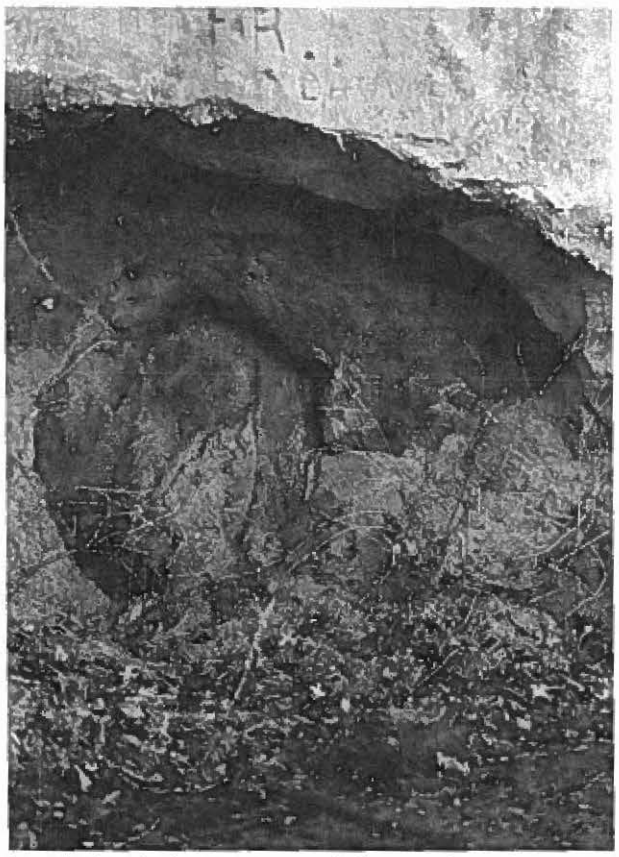
Dripping Springs are 300 meters north of Brogdon Springs. Their water seeps from cliffs of Woodbine sandstone covered with maidenhair ferns, bitter cress, and moss. It is reported that horse thieves were hung from a walnut tree here.

In 1874 Buckley described some oil springs (16) near the Rock Bluff cattle crossing northwest of Denison:

> To-day, I went, with Mr. E. C. Ramage as guide, to examine an oil spring, which we found in a high bluff of the banks of Red River, fourteen miles northwest of Sherman, and one mile from the Rock Bluff, crossing on that river. At this spring, or sipe, the shellrock, so common in the northwest, I found overlying a soft sandstone; the former eighty feet thick, the latter twenty. The oil sipes from the crevices of the soft sandstone. The whole of the sandstone is saturated and dripping with oil.

Mrs. Joe Dopheid, who lives nearby, says these springs no longer exist. They may be beneath the waters of Lake Texoma. More likely, the great amounts of water and oil which have been withdrawn from the formations in this area have so lowered the water and oil tables that they no longer flow. Traces of oil can be found in other springs farther west along Lake Texoma.

Cooke Springs (13) were seven kilometers southwest of Denison and ½ kilometer north of Highway



Inscriptions in the sandstone bluff above Sand Springs.

691. They were well known and much used by early residents of the area. Livermore showed them on his 1883 map. Hill described them in 1892. Formerly flowing from Woodbine sand, they are now unfortunately dry.

Two kilometers northeast of Cooke Springs are the similar **Moss Springs (12)**. Here Micajah Davis built his log cabin in 1837. For many years the springs were used by travelers on an adjacent wagon road, the trace of which can still be seen. The springs produced 0.15 lps in 1976 from Woodbine sand. They are now on Bill Hollingsworth's farm, but will soon be covered by a new highway.

A second **Sand Springs (11)** is three kilometers southwest of Denison, just downstream from the right abutment of Waterloo Lake dam. This was a watering place for California-bound gold seekers, stagecoaches, and cattle drovers in the 1840s and 1850s. For many years residents came from miles around to fill jugs and wash clothes at the springs. A marker 100 meters south commemorates this historically important spot. A very small flow of 0.18 lps still seeped in 1976 from high cliffs of Woodbine sandstone covered with green lichens. Numerous names and dates have been carved in the soft rock over the years.

Miller Springs (10) are located at 1901 West Walker Street in Denison. The site was occupied by American Indians before J. K. Miller built a cabin here in 1852. A later log house built in 1866 is still preserved by the present occupants, Mr. and Mrs. W. R. Blood. Stagecoaches stopped here in the 1850s. The springs produced 0.20 lps in 1976 from Pawpaw sandstone. Two large sycamore trees northwest of the residence still mark the location, which has been partially covered by highway and railway fills.

Tanyard Springs (14) are about midway between Sherman and Denison on the abandoned right of way of the Sherman and Denison Railroad. From their name it appears probable that they were once used in a tannery operation. In 1901, to promote travel, the railroad built Woodlake Park, with a lake which covered the springs, boats, a zoo, opera house, and dance pavilion. A historical marker two kilometers west describes this first Texas interurban line. The park is now no longer used, and the lake was on December 22, 1976, at a low level, indicating that there is little spring-flow. Juanita Beach, manager of the property, states that the springs no longer flow as they did 30 years ago.

A second **Dripping Springs (15)** are just north of the cemetery of this name, 11 kilometers northeast of Sherman at latitude 33°41' and longitude 96°31'. The first Baptist church in the county was established here. Presently only seeps emerge from Woodbine sand.

At Carpenters Bluff, where Highway 120 crosses the Red River east of Denison, are **Carpenter Springs (9)**. These springs, whose waters are high in iron, issue from river terrace sands beneath the southwest end of the bridge. They were popular with travelers who made use of the ferry which formerly existed here. In June 1959 and December 22, 1976, the discharge was 0.13 lps.

An old settlement was made at **Everhart Springs**, immediately west of Everhart cemetery, six kilometers northwest of Whitewright. Here 0.06 lps issued in 1976 from the Bonham marl (7).

Five kilometers north of Tom Bean and just north of the Cedar cemetery are **Cedar Springs (6)**. A marker at the church just to the north commemorates the settlement of a pioneer community around the springs in 1848. For many years people came long distances to camp here for revival meetings. Amid many cedar trees the fresh-water springs still flow from Austin chalk.

Cold Springs (20) are four kilometers east-southeast of Van Alystyne. They are now in a lake on Jesse Joe Savage's ranch. A mill was once located here,

later a still, and the spot was very popular for picnics. Bass gather around the springs in the lake, indicating that they still flow.

Ten kilometers southwest of Sherman, at latitude 33°35' and longitude 96°41', are **McKinstry Springs (2)**. An early settler by this name built a rock fort here. Previous to this the Choctaw Indians lived at the springs. Encompassed by a willow grove, a flow of 0.65 lps still emerged in 1976 from the base of the Austin chalk.

Three kilometers south of Tioga, on Charles Boerner's farm, are **Copperas Springs (4)**. Numerous Indian relics found here point to their long use as a campground. Emerson Chapel cemetery, just west, has graves dating back to the 1860s, indicating that white settlers also were attracted to these springs. The water, high in iron sulfate, flowed from Woodbine sand at 0.55 lps in 1976. **Pierce Springs**, three kilometers west, produced 0.10 lps.

Tioga Springs (3) are just west of the railroad tracks at Tioga. In 1788 Pedro Vial may have stopped here en route from Santa Fe to Natchitoches. The springs were a very popular health spa in the 1880s. As the table of Selected Chemical Analyses shows, the water is highly mineralized. According to Mildred Milner, there were in their heyday five hotels which dispensed baths. The water was reported to be beneficial for skin ailments, and was also used internally. A lake was built and used for boating during this period. The lake is still there, but the springs have nearly vanished because of pumping from many wells in the same aquifer, a Quaternary sand. The water is now sold by the bottle, and mineral-water baths may still be had in Tioga.

GREGG COUNTY

The springs of Gregg County have been used for many thousands of years by early Americans. First the hunting and gathering Paleo-Indians camped at the springs. Then agricultural mound builders raised crops near the water. At the dawn of historic time the Caddoes lived in villages of thatched houses at the springs.

Most of the springs issue from Tertiary Eocene sands, primarily the Carrizo, Reklaw, and Queen City. These sands dip mostly toward the west into the East Texas embayment at about three meters per kilometer. Some springs run from Quaternary terrace sand and gravel, especially along the Sabine River.

Most streams are spring-fed and run the year around. The groundwater table has suffered from man's activities chiefly in areas of heavy municipal or industrial pumping. At Kilgore, for example, the water level in the Carrizo aquifer declined 0.40 meter per year from 1931 to 1966. Some springs have been buried beneath sediment from past accelerated erosion of cleared and plowed land. As there are so many springs in the county, only those of some historical or other importance are discussed.

The spring waters are generally of a sodium bicarbonate type, fresh, soft, and of neutral pH. The iron content may be high. Most of the writer's field studies were made during the period January 12 - 17, 1978. As an ice storm occurred during this time, the observed discharges are believed to be above normal for this season.

Five kilometers west-southwest of Longview, on Martin Franklin's property west of Highway 1845, was **Calvin Spring (7)**. Here in the early 1900s was an interesting spring on the former L. G. Calvin farm. It produced bubbles of gas which would burn, foreshadowing the oil boom which later struck the county. The spring is now under a small lake in some woods.

Fifteen kilometers west of Longview, on the northwest side of Merril Lake, are **Moore Springs (12)**. In 1936 the two springs flowed 0.63 liter per second in a road ditch. Now they are beneath a borrow pond covered with duckweed. The area has been greatly disturbed by oil-field operations.

About ½ kilometer west are some reliable springs in the Sabine River channel. According to Ed Wykoff, a nearby resident, they are often used for making coffee by fishermen. On January 16, 1978, they were covered by high water in the river.

Rock Springs (13) are five kilometers south-southwest of Gladewater, southeast of Rock Springs school. From 1849 to the 1930s the water was used by the school, which is marked by a historical medallion. The school was also used for church, social, and political meetings. The very small springs flow from Queen City sand.

Spring Hill Springs (14) are nine kilometers northwest of Longview and two south of the present Spring Hill community. Here the 1887 Spring Hill school was located beside "a spring in a cliff." Herman Fenton of Spring Hill remembers the school, which is now gone. Although the springs have been badly disturbed by highway construction, they still (1978) trickle 0.35 lps from Queen City sand. The Spring Valley subdivision is now being developed around them.

Willow Springs (11) are in west Longview near the junction of Highways 80 and 281. According to Mrs. Paul Belding of Longview, a sawmill used the waters in the 1830s. They were important to the set-

tlers, and were shown on several early maps, including J. F. Elliott's 1888 *Latest and correct map of the state of Texas*. The springs still cause much trouble with foundation preparation, according to R. E. Darby, owner of Darby Equipment Co.

Rockwall Springs (10) are five kilometers west of Longview on Mrs. Sears Brazzell's property. They were once used as a stage stop on the Shreveport-to-Tyler route, according to Mrs. Belding. The Rockwall addition, developed by the Beldings, is adjacent. The small springs still flow from Queen City sand.

In the Northcutt Heights section of Longview were several springs (9). An important one, which still flows weakly, was at the intersection of North Court Street and West Gate Avenue. According to Earl Smith of Longview, religious services were held in a brush arbor here. Residents from a wide area came to the spring for water. On June 19, Emancipation Day, a barbecue was usually held here. Another spring which Smith remembers from his childhood (1901 to 1918) was near the intersection of North Center Street and West Hudson Avenue. It has now been paved over.

The T and P Pond was located near Bolivar Street and the T and P Railroad in east Longview. Being fed by springs (8), it was popular for swimming in the 1890s. As it became filled with modern sediment it was used for fishing. Later the lake was drained. Now there are only intermittent seeps in Teague Park, just north of the former lake.

Camden Springs (6) are in the old Camden community below a bluff on the south side of the Sabine River. Just north of Easton, they are on Anderson Garrett's farm. Sam Houston stopped here in 1832. Later Wallings Ferry crossed the Sabine adjacent to the springs. They also became a stage stop on the Palestine-Shreveport road. Many very small springs and seeps still trickle from river terrace sand at the base of the bluff.

The Fredonia settlement is commemorated by a historical marker seven kilometers southwest of Longview on Highway 2087. Here a Sabine River port and ferry crossing was established in 1825. Very small springs and seeps (3) flow from Carrizo sand at the base of the river bluffs on Porter Horton's and Willie Atkinson's farms. They were doubtless used by early residents. The Hortons still obtain house water from some of these seeps.

Eleven kilometers east of Kilgore are **Whittington Springs (5)** on Peatown Branch at an elevation of 90 meters. The Blue Hole northwest of Peatown cemetery and church was formerly used for baptizing, but is now filled with modern sediment. A park northeast of the church made good use of the spring waters at one time. On January 15, 1978, 1.3 lps of iron-rich water passed Highway 2011, flowing from Reklaw sand.

Gum Springs (4) are eight kilometers east of Kilgore on Gerald King's ranch. Here, commemorated by a historical marker, was the 1849 Gum Springs log church. The springs are now only seeps in a pond frequented by many killdeers. Probably their flow was reduced when a head of water was placed over them. In 1978 other springs produced 0.075 lps 1.2 kilometers west of the church site, feeding Crazy Bess bayou.

Clayton Springs (2) are four kilometers north of Kilgore on the William Clayton oil lease. They were formerly used as a domestic water supply, and also for oil-well drilling in the 1930s. In 1936 they were described as "never failing." Their yield in 1936 and 1978 has remained around 0.65 lps of iron-bearing water from Carrizo sand. An old rock dam surrounds the springs, whose waters contain much marsh purslane and water pennyworts, shaded by honeysuckle.

Ten kilometers west of Kilgore in the southwest corner of the county are **Dansby Springs (1)**. In 1978 these "never failing" springs produced 0.63 lps from Queen City sand. They are the chief source of Helton Creek. In 1788 Pedro Vial may have stopped here en route to Natchitoches.

HALE COUNTY

No springs any longer flow in Hale County. At one time many issued from the Ogallala sand, gravel, and caliche, which dip gently toward the southeast. The formation, which was largely saturated with water formerly, varies in thickness from about 20 to 125 meters. Water moves through it at about 20 meters per year.

Archeological studies indicate that the springs and spring-fed creeks were popular living sites long ago. At the Plainview site about 100 bison were killed around 10,000 years ago using flint-tipped spears. At the dawn of historic time, Running Water Draw still flowed continuously through most of the county.

Many plants depended upon the spring waters for their existence. These included cottonwood and willow trees, plum thickets, grapevines, cattails, rushes, water cress, and milfoil. Animals similarly relied upon the water. Most notable were fish, frogs, snakes, turtles, crawfish, and water insects, as well as the larger animals which preyed upon them. The lakes, brimful and fed by springs and seeps, made perfect havens for ducks, geese, cranes, and other waterfowl. With the drying up of the springs and lakes, most of these plants and

animals have disappeared.

Although there were other causes of the great decline in the water table, irrigation pumping of groundwater is by far the greatest culprit. The first irrigation well in the county was drilled in 1910, but the great expansion occurred in the 1950s. In 1964 irrigation wells discharged 1.35 cubic kilometers of water, or more than 20 times the annual amount of natural recharge. From 1937 to 1967 the water table declined more than 24 meters in the northeast. This was the primary cause of the failure of the county's springs.

In addition, severe sheet erosion of steeply sloping cultivated land along the draws has filled many channels and buried springs. This land, of course, should never have been plowed.

The spring waters were of a calcium bicarbonate type, generally fresh, very hard, and alkaline. The content of silica and fluoride was usually high.

Most of the writer's field studies were made during the period September 23 - 28, 1978.

In the northwest corner of the county, two kilometers from the Lamb County line on Running Water Draw, were **Norfleet Springs (10)**. According to John Norfleet, who was born here in 1924, 12 or 13 springs bubbled up in a swimming hole in the 1930s. The many flint points and scrapers found here confirm that this was a living site in prehistoric times. The springs failed around 1945. The swimming hole, now partially filled with sand, occasionally contains storm waters. Arrowhead plants, pondweed, and pink-flowered smartweed adorn the site. Starting one-half kilometer downstream the channel is lined with cottonwoods and willows, most of them dead or dying.

A little farther downstream on Running Water Draw, 10 kilometers west of Edmonson on Rodney Heck's ranch, were **Morrison Springs (9)**. Here many flint points and the remains of prehistoric horses have been found. The J. N. Morrison ranch watered its stock at these springs starting in 1881. An old windmill here probably contributed to the springs' demise. Some pools of live water persisted until about 1948. A few cottonwoods and willows still survive.

Eight kilometers west of Edmonson on Newton Hilliard's ranch were some well-known springs. They were called **Ojo de Agua (8)** on a 1789 *Map of the territory between the province of New Mexico and the fort of Nachitoches in Texas*. When the Morrison ranch headquarters stood here, these and other springs maintained a running stream in Running Water Draw, where fishing was good. The springs issued from Ogallala sand and caliche in a bluff at a bend in the creek. A dugout house was once located here. The old ranch headquarters house has now been restored. Several wells pump near the springs, which dried up in the 1950s. Some seepage continued in the 1960s. A grove of dying cottonwoods and other trees shades the place.

Five kilometers west of Edmonson on Frank Gabriel's farm were **Jones Springs (7)**. Here Will and Thornton Jones built a dugout in 1897 and dammed Running Water Draw just downstream to form an excellent fishing lake. The channel is now filled with sand and most of the cottonwood trees at the site are dying. Many irrigation wells pump nearby.

In 1884 Dennis and Martha Rice built a dugout four kilometers south of Edmonson, where the Running Water community later grew up. **Running Water Springs (6)** were nearby on the north side of the draw. Much earlier there was an Indian campsite here. Mrs. A. B. Cox of Plainview remembers these springs flowing in the 1920s when there were many fish here. Soon afterward, according to Mrs. Bill Pinkerton of Edmonson, they dried up. For the following few years it was possible to grow sub-irrigated alfalfa in the draw, but soon the falling water table made this impossible. Trees buried to their lower branches indicate that up to four meters of sediment from modern erosion has filled the draw. The cottonwoods which grew here in the 1920s are gone, replaced by a few hackberry and mulberry trees.

At the foot of Cedar Street in Plainview is a historical marker commemorating two hackberry groves on Running Water Draw. This was a favorite stop of Indians, buffalo hunters and surveyors. In 1886 Zachary Maxwell established a sheep ranch here. On July 4, 1903 a celebration was held in the groves. At that time springs (1) kept Running Water Draw running. There was abundant grass and many fish. By the 1920s the draw flowed only intermittently through town. The springs in this vicinity dried up in the middle 1940s. One hackberry tree still survives.

The lower end of Running Water Draw in Hale County had less springs, and they dried up early. Seven kilometers southwest of Aiken the water table in the draw was very shallow (2). Berwin Tilson's father in 1903 dipped water out of a shallow well here from a depth of 1.6 meters with a cup on a bridle rein. By 1974 the water level had sunk to about 65 meters below the surface, and the floodplain was all in cultivation.

Farther south is Callahan Draw. Here, on Dan Houchin's farm 15 kilometers southwest of Aiken, were once some springs (3). They were shown on G. L. Gillespie's 1875 *Map of portions of Texas, New Mexico, and Indian Territory*. The Ogallala sand is thin here and no irrigation wells are present. The springs dried up

Dead cottonwood tree at site of former Eagle Springs.

many years ago. A lake into which they flowed is now dry except for occasional surface runoff. A few hackberry trees and much pink-flowered smartweed decorate the site.

On Crawfish Draw there were once small springs about 12 kilometers south of Hale Center. Frank "Pete" Norfleet of Hale Center recalls these **Crawfish Springs (4)** for which the draw was named, flowing intermittently from crawfish holes. By 1920 they had dried up.

Eagle Springs (5) were 12 kilometers west-northwest of Abernathy on Blackwater Draw, on William and Mac Houston's farm. In early days Cora Lake was fed by the springs. Col. R. S. Mackenzie's forces camped here in 1872 while chasing Comanches. This was later a popular watering place for cattle and a campground for travelers, according to Norfleet. In 1898 a lighted cigar thrown into the high dry grass near the springs started a catastrophic grass fire. Fanned by high winds, it burned an area larger than four counties before it died out. An old grave is located here. Eagle Springs school was two kilometers southeast. The springs dried up in the early 1930s, but seeped intermittently in the 1940s. The lake and draw have been buried under sand. Several dead cottonwoods mark the spring site. Mesquite trees and jackrabbits abound.

HALL COUNTY

Some of the best remaining springs in Hall County issue from Quaternary sand deposits which cover the underlying Permian formations, especially in the northeast. Many springs formerly trickled from Permian Quartermaster and Blaine sandstone and gypsum. These are nearly all dry now.

Long ago, when Paleo-Indians frequented the springs, nearly all of the creeks ran continuously. Many Indian artifacts have been found along the creeks, including bedrock mortar holes, metates, manos, earth and rock ovens, and stone points and tools. Early in the nineteenth century Mexican sheepmen began to settle near spring-fed creeks. They were driven out or killed by the cattle barons by 1885.

The spring-fed streams supported a unique assemblage of plant and animal life. Panthers, bears, wolves, antelope, badgers, wildcats, and deer were abundant. In the 17th century Spanish cattle and horses began entering the county. The many lakes were full of water, providing havens for waterfowl. Quail and prairie chickens were sold by the towsack in Memphis. Wild plums and grapes were plentiful. Most of these animals and plants have now disappeared along with the springs. But former spring-fed streams may usually be recognized by the cottonwoods, willows, hackberry trees, salt cedar, and rushes, replacing the mesquite trees which prevail elsewhere.

Man's activities have caused a great decline in the water table. Near Turkey it was as much as 8.8 meters between 1960 and 1969. This is the major cause of the failure of most springs.

In addition, catastrophic gully erosion has taken place. Abandoned terrace systems show where land was plowed on slopes altogether too steep for cultivation. Most of these gullies are now inactive and partially healed because the high water table which facilitated caving is now gone. But the damage has been done — creeks and lakes filled with sand and springs buried. In many locations trees buried to their lower branches may be seen.

The water is usually of a calcium sulfate type, because of the influence of gypsum. It is generally slightly saline, very hard, and alkaline. In some cases brine springs, such as Estelline Salt Springs, issue from Permian shales. The primary dissolved-solids constituent of these waters is sodium chloride.

Most of the writer's field studies were made during the period August 27 - September 2, 1978.

In western Hall County there are numerous brine seeps along the Little Red River and Prairie Dog Town Fork of the Red River. In dry weather these produce a very white crust along the river beds. On the Little Red River the discharge of brine was estimated on January 28, 1971, to be 2.0 lps. This originated from numerous seeps and very small springs, chiefly in Briscoe County. The concentration of salts averages 150,000 milligrams per liter, or more than four times as salty as sea water.

On Prairie Dog Town Fork numerous brine seeps occur at the mouths of tributaries near Brice. Their concentration of dissolved solids ranges from 4,000 to

32,000 milligrams per liter.

Five kilometers northwest of Lesley was Bitter Lake. It was fed by springs (4) from Quaternary sand. Joe Neal Berry, who leases the land, used to catch large fish in the lake in the 1930s. The springs dried up in the 1940s. The lake, which was surrounded by cottonwoods, was later filled with sediment from Bitter Creek. The trees have been cut and the lake is now being farmed. Irrigation wells pump throughout the surrounding area.

Deep Lake was seven kilometers southeast of Lesley. **Deep Lake Springs (5)** to the north kept the lake full. Petroglyphs on rocks nearby indicate that this place was a favorite haunt in ages gone by. Until 1880 the Comanches under Quanah Parker camped here while on hunting trips. In 1880 Capt. G. W. Arrington stopped here while hunting Indians. In 1884 a post office was established at the springs. According to Lois Monzingo of Memphis, many early residents hauled water from the springs. They were a recreational center and the scene of numerous picnics and baptisms. Many people thought the lake to be bottomless until the springs and lake dried up in the 1940s. The springs ran from Whitehorse sandstone and Cloud Chief gypsum. Their location is still marked by some willows and an old windmill. The lake is now cultivated and many irrigation wells pump nearby. A small irrigation return-flow pool attracts ducks, doves, and quail.

In 1884 the Shoe Bar ranch headquarters were established three kilometers north of Lakeview. Bobbie Barbee still lives in the old house. Oaks Creek at that time flowed continuously past the headquarters, fed by springs (6) which poured from terrace sand. The long wooden bridge across the creek here is no longer needed, as the springs and creek are dry. The channel, now filled with sand, is still fringed with cottonwoods. **Bevers Spring**, two kilometers east-southeast, ceased flowing in 1965.

Spring Creek Springs (7), which fed Spring Creek, are five kilometers east of Lakeview on Sandy Smith's farm. Many Indian projectile points and metates have been found here. In 1907, according to Mrs. Robert Clark, there was a spring at a cottonwood tree at the head of Spring Creek where many wagon trains stopped. It dried up in the 1940s. On January 6, 1969, there was still a discharge of 4.0 liters per second downstream at the Highway 2472 crossing. On August 31, 1978, the flow at this point had decreased to 0.21 lps, and farther downstream, at Highway 1041, there were only pools of standing water. The springs issue from Quaternary sand, amid salt cedar, cattails, and rushes.

Bugbee Springs (17), the largest remaining in the county, are eight kilometers west of Memphis. On January 8, 1969, they produced 1.2 lps. On September 2, 1978, the discharge was 0.95 lps from alluvial sand and gravel on top of Permian shale. Swarms of minnows cavort among the rushes, shaded by willows. Many fishermen seine minnows for bait here. The flow runs to Indian Creek. Other small springs trickle on Indian Creek upstream from Highway 2361.

Near the mouth of Indian Creek there was once an Indian village. At that time the creek (16) ran continuously. Pedro Vial and his companions probably stopped here in 1788 en route to the Taovayas villages in present Montague County. Now the creek is dry and choked with sand. Salt cedar, cottonwoods, rushes, and cattails may still be seen.

Wilson Springs (8) once flowed on upper Parker or Berkley Creek two kilometers southwest of Memphis. A metate and many projectile points have been found here. A large swimming hole existed at the springs in early days. According to Grace Wilson, by 1927, when her father built a swimming pool at the site, the springs were dry. The springs were influenced by barometric presure, flowing more copiously before the arrival of stormy weather. A grove of elms, willows, and cottonwoods still stands at the place.

Eight kilometers east-southeast of Memphis is Bryant Lake on Terry Monzingo's farm. Here in 1915 men and women were first allowed to bathe together, according to Byron Baldwin of Memphis. The lake was also popular for duck hunting, but in recent years has usually been dry. **Bryant Springs (12)** fed the lake, but are now reduced to seeps from Quartermaster sandstone and gypsum. Jonah Creek to the west is dry except for storm runoff, but downstream in Childress County it produces salt springs.

Estelline Salt Springs (11) are one kilometer east of Estelline on the floodplain of Prairie Dog Town Fork of the Red River. Around the turn of the century the springs became active at this location, washing out a funnel in the alluvium at an elevation of about 541 meters. The diameter at the land surface is about 45 meters. Divers have descended to a depth of 38 meters, below which the opening narrowed to 1.2 meters or less and the upward flow of water was too strong to penetrate. Other sinks nearby, now partially filled with sand and clay, indicate former outlets for the springs. In 1964 the U. S. Corps of Engineers built a 2.4-meter-high dike around the springs to confine them and prevent the salt from entering the Red River (see Plate 8, a). Gene Bruce, who leases the surrounding land, takes periodic water-level measurements and samples of the spring water.

According to Bruce, in the 1920s several boys were drowned in **Salt Hole**, one of the now inactive springs. During World War II the springs were much used for swimming by service men stationed at Childress, and bathhouses were built.

Observed discharges are as follows:

May 26, 1943	59	Oct. 27, 1960	113
Sep. 18, 1945	68	1963	79
Jan. 11, 1954	88		

Since 1964 when the springs were confined, there has been no flow. The bottom of the pool will probably become clogged, as there is no longer a current to flush out the sediment. It is possible that the springs will break out elsewhere on the floodplain.

The total-dissolved-solids content, chiefly sodium chloride, has ranged from 44,000 milligrams per liter in 1960 to 55,400 in 1977. The pool water is apparently becoming more saline since its confinement and exposure to evaporation. The highly mineralized water is classed as brine. The salt is believed to originate from the Flowerpot shale.

Salt minnows or killifish swim among the milfoil. Saltwort is abundant on the surrounding flats. An endemic saltwater crab was known to live only at these springs. Whether it survives since the springs have been confined is questionable.

Mill Iron Springs (9) supplied the Mill Iron ranch when it was established in 1888 on Rustlers Creek five kilometers south of Estelline. The site, on Ada Jones' property, still boasts some cottonwood trees. Arthur Eddleman of Estelline recalls that Rustlers Creek flowed most of the time here in 1909. Henry Williams remembers running water in the creek upstream from Highway 658 around 1925. The creek is quite dry now except for storm runoff. Mountain Creek to the north still seeps a little water in winter.

Running Water Creek, as its name indicates, was once fed by many springs (10). Located nine kilometers southwest of Tell on W. H. Tippett's ranch, it is now fed only by some seeps in winter. A few cottonwoods, willows, and rushes survive along the creek. Baylor Creek to the north was a favorite haunt of Indians, according to A. V. McFarland of Childress. At that time it must have run a plentiful stream, but now it too has only some winter seeps.

The area around the junction of the Red River, Little Red River, and Bullard Creek was a very popular one with ancient peoples. Archeological sites covering a range of time from Archaic (perhaps 7,000 years ago) to historic times have been found here. There were excellent springs (13) on Bullard Creek in those days. In 1872 buffalo hunter Jacob Fields built a dugout near the mouth of Bullard Creek. Crump Farrell, a nearby resident, remembers when the creek flowed throughout its length continuously, until it dried up before 1945. There are now only a few winter seeps near the mouth of the creek, with much salt cedar and mesquite. Carl Hill owns the ranch, which is worked by his son-in-law, Frank Hedrick.

Chimney Mountain Springs (1) were 15 kilometers west-northwest of Tell on Jack Johnson's ranch. Many metates and projectile points have been found here. An early settler built a dugout near the springs. They dried up before 1948, when A. W. Johnson moved here. Salt cedar and a salt crust on the ground still mark the site.

Six kilometers farther west were **Ridge Springs (2)**, a site now on Bob Butler's Badger Nest ranch. Here in 1875 Bob Jones ran a camp and buffalo store. It also served as a relay station for mail riders between Seymour and Old Clarendon. The springs, long dry, apparently trickled from Cloud Chief gypsum near the ridge. Many cedars and live oaks thrive here. Some winter seeps may still be found in Housetop Canyon to the east.

Deer Springs (3) once fed Deer Springs Creek 20 kilometers east-northeast of Turkey on Mac Hinkston's ranch. They are now dry, but a few cottonwoods and many cedar trees grow here. The adjacent cliffs are covered with swallow nests.

In 1891 Alex Lyles settled at "a fine spring" (14) three kilometers east of Turkey. The ranch is now owned by John Deaver and operated by Earl Twilla. The long-dry springs poured from sand and gravel on top of Quartermaster shale. Many cedars adorn the slopes, which have been severely gullied. At the Archaic Twilla site nearby an ancient people butchered bison.

Colvin Springs (15) were four kilometers west of Turkey on George Colvin's farm. In early days many women from Turkey brought their clothes here to be washed. The springs issued from a sinkhole in Quartermaster gypsum. On April 18, 1969, the discharge was 0.88 lps, but soon afterward the flow ceased. A grove of willows and cottonwoods stands at the site.

HANSFORD COUNTY

The springs which still flow in Hansford County originate from Ogallala sand and caliche and the underlying Dakota sandstone, chiefly along the major streams. At one time they were numerous. Abundant

finds of stone artifacts and cave drawings have been made near former springs, which were doubtless popular campsites of ancient people. As recently as the 1920s, according to John Knight of Stratford, all of the larger creeks in the county had flowing water in them.

Groundwater levels have declined fearfully in recent years, mostly because of the tremendous increase in pumping for crop irrigation. From 1965 to 1970 the decline ranged up to 8 meters. As the water table falls, many windmill wells must be either abandoned or deepened. Many of the more desirable grasses can no longer reach water, and are being replaced by desert plants such as yuccas. As a consequence of the falling water table, most of the county's springs have failed. In addition, plowing up of the natural grassland in the past resulted in severe sheet erosion and headward cutting of valley trenches. This sediment moved downstream, filling all the former deep fishing and swimming holes and burying many springs.

The spring areas were formerly alive with wild game. Flocks of 150 sandhill cranes were common. Wolves, bears, bison, antelope, foxes, prairie dogs, wildcats, badgers, and geese all depended upon the springs for their food and water. Wild horses, brought by Spanish explorers 400 years ago, became so numerous that they had to be fenced out. With the failure of most of the springs and the loss of their natural habitat, most of these animals can no longer survive in the area.

The spring waters are normally of a calcium bicarbonate type, fresh, very hard, and alkaline. The fluoride content may be high. The writer's field studies were made primarily during the rainy period of May 26 - 31, 1977.

Frisco Creek was probably spring-fed at one time, although no springs remain now. John Knight of Stratford recalls running water on Frisco Creek in Oklahoma just downstream from the state line in 1913.

Coldwater Creek flowed through most of its length in early times, with many deep holes full of fish. Now it is dry except during storms and the holes have been filled with sand. Tom Pugh of Texhoma remembers springs (1) which flowed until 1962 in a cottonwood grove on the creek just east of Highway 15.

Martin Springs (1) were farther downstream on Coldwater Creek on the Bob Cluck ranch at latitude 36°20' and longitude 101°33'. They were named for Sheriff Robert Martin, who was killed here in 1911 in a boundary dispute. In 1936 their discharge ranged from 0.63 to 13 liters per second. In recent years they have gone dry and are not expected to flow again. Now blue-eyed grass brightens the site, shaded by willows and cottonwoods, some dying.

Farther downstream on the right bank of Coldwater Creek, one kilometer south of the Oklahoma state line on the old Charlie Hitch ranch, were **Hitch Springs (5)**. These springs fed Coldwater Creek constantly in 1914, according to Pugh. They came out of Ogallala sand on top of Dakota sandstone and conglomerate, which forms a bluff with overhangs. Although dry, the site is still marked by a hackberry tree.

Seven kilometers east there was in times past a lake, called McComas or Hitch Lake. It was nearly always full of water, according to several old residents, and very likely was fed by springs (4) from the surrounding sand hills. It is now dry and receives only infrequent flows of storm runoff.

Six kilometers southeast of McComas Lake were **Lowe Springs (3)** on Hackberry Creek. Here Robert Lowe built a cabin in 1893. The springs are now dry, and an earth stock tank is fed only by surface runoff. Other small springs used to run a few kilometers downstream in Oklahoma.

Palo Duro (Hard Wood) Creek was fed by abundant springs 100 years ago. Gould (1907) mentioned several early irrigation projects utilizing the spring waters, including one of 14 hectares. John Knight says the fishing was very good northwest of Spearman as late as the 1930s. The Dodge City - Tascosa cattle and stagecoach trail of the 1880s followed Palo Duro Creek through the county, no doubt because of the plentiful water.

Fourteen kilometers south-southwest of Gruver are **Near-to-Nature Springs (7)**, in a former park of the same name, on the Gid Nobles ranch. In 1793 Pedro Vial probably stopped here on his return to Santa Fe from St. Louis. Here the Cator buffalo camp was established in 1872, during that infamous period of slaughter of these animals. The rock house still stands southwest of the springs. In 1873 the Zulu stage stop was located here. In 1936 the springs produced 0.32 to 0.63 lps. In 1977 Palo Duro Creek had cut into them, but 0.13 lps still trickled from sand at an elevation of about 965 meters. The grove of hackberry and chinaberry trees with grapevines is still popular for outings. A few smaller seeps reportedly still exist for a few kilometers downstream.

At the old town site of Hansford, in Palo Duro Canyon ten kilometers west of Spearman, Indians camped at former springs (8) in historic time. Eight to sixteen kilometers farther downstream, on Jack Lasater's ranch, is a very rugged area of rocky bluffs, cedar trees, rock shelters, and large boulders. Archeological studies of artifacts found here demonstrate that people of the Archaic stage lived here up to several thousand

years ago. Springs undoubtedly poured from the hills then, but they are dry now.

Still farther downstream in Palo Duro Canyon, ten kilometers from the Oklahoma state line, are **Slough Springs (2)**, on the Emmy Brillhart ranch. They still seep intermittently from terrace sand, maintaining some "live" water in the creek, but probably will not last many more years. A grove of cottonwoods and willows shades the spot, and prairie dogs romp nearby.

On a tributary about six kilometers west of Slough Springs, on Don McClain's ranch, are **Lindsay Springs (9)**. Many stone projectile points found here point to the springs' early use by prehistoric people. They are little more than seeps now, chiefly supplied by irrigation waste water from the cropland upstream. But they still maintain a pool containing fish, fringed with willows and cattails, and surrounded by fields of yellow day primroses.

HARDEMAN COUNTY

The springs of Hardeman County were once used by an agricultural people to irrigate corn, beans, melons, and other crops. After about 1700 the nomadic Comanches and Kiowas took over the spring campsites.

The springs issue chiefly from sand and gravel terraces along the Red River, and to a much smaller extent from Permian sandstones and gypsum. The water is generally of a calcium bicarbonate type, very hard and alkaline. That from terrace deposits is normally fresh, while that from Permian formations is slightly saline.

Water tables have declined greatly, chiefly because of well pumping, and the spring flow has consequently lessened and in many cases stopped. Most of the creeks formerly ran the year around, providing much swimming, fishing, and boating for the early settlers, but this is no longer the case. Severe erosion has buried some springs beneath sediment.

Lindsay Springs.

Most of the writer's field studies were made during the period September 10 - 15, 1977.

Let us discuss the springs in a clockwise direction around the county, starting in the northwest corner. In the extreme northwest were **Vaughan Springs (9)**, on Benny Vaughan's property, leased by Joe Lindsey, at latitude 34°32' and longitude 99°58'. Here A. V. McFarland of Childress has found evidence of Indian campsites of Archaic as well as more recent age. G. W. Colton's 1876 *New map of the state of Texas* depicted these springs, which were undoubtedly important to the early settlers. In 1969 they still produced 3.2 lps from sand on top of shale. Now they are covered with sand and marked only by a grove of willows, salt cedars, and dying cottonwoods.

Farther east, on Papoose Creek, at latitude 34°29' and longitude 99°51', were **Brooks Springs (2)**, on the A. J. Norton farm. Bill Brooks' ranch camp was located near here in the 1880s. The springs formerly kept Papoose Creek flowing continuously. Now they are dry, the channel is full of sand, and the tops of buried fences may barely be seen. Squaw Creek a few kilometers south still has a few small springs.

Thirteen kilometers northwest of Quanah are **Sparks Springs (3)**, the largest in the county. In 1788 Pedro Vial and his companions may have stopped here on their journey from Santa Fe to Natchitoches. On Jack Hunter's farm, the springs were settled in 1886 by S. H. Sparks. Originating in gypsum, at an elevation of 440 meters, they form a series of pools on North Groesbeck Creek which were formerly very popular for fishing. In 1969 they produced 22 lps and on September 12, 1977 about 9.5. A grove of willow and hackberry trees with cattails, yellow saw-leaf daisies, and white-purple thelypody flowers surrounds them. They sometimes dry up in summer when irrigation wells nearby are pumping.

Five kilometers north-northwest of Quanah, on the old Watkins' farm, are **Watkins Springs (10)**. On Don Bethel's place, in 1977 they poured about 0.19 liter per second from Permian gypsum into two small lakes. In the 1920s a gypsum mill and hotel were located here. The upper lake was much used for swimming. In the 1920s the spring supplied a swimming pool.

In 1888 **Quanah Springs (8)** kept Spring Creek flowing from Quanah city park to Groesbeck Creek. Now there is only a small pool of standing water in the park, derived from Permian sandstone.

Eleven kilometers northeast of Quanah were some springs (4) on the Wilson ranch. In 1876 G. L. Gillespie showed them on his *Map of western territories*. They are now only pools of standing water among willow and

hackberry trees.

Sixteen kilometers northeast of Quanah, close to the Red River, are some small springs (5) on the Schmoker and Hill ranch. These are very likely the remains of **Wormwood Springs**, shown on Burke's 1885 *Special map of the great southwest* and Gillespie's 1876 map, although no one now living in the area knows them by this name. Until about 20 years ago, according to Raymond Bryant, Ewell Hollow, into which these springs flow, ran continuously. It was fed by many springs and provided excellent fishing for an Indian village about five kilometers from its mouth. In 1977 a discharge of 0.085 lps seeped from sand in a grove of large elms. Beavers still build dams on the creek, but probably not for long.

In the northeast corner of the county on the Harold Gibson farm, at latitude 34°23' and longitude 99°30', springs (11) formerly sparkled. These were probably the **Foster Springs** depicted on G. L. Gillespie's 1875 *Map of portions of Texas, New Mexico, and Indian territory* and on his 1876 map. Mr. Gibson in past years hunted in the large grove of trees surrounding the springs. In 1969 they poured forth 1.6 lps, but dried up soon afterward. An irrigation well is located close to the springs site.

Four kilometers south were **Moffet Springs (12)**. They discharged 0.25 lps in 1969. They are now dry, and buried under sand from erosion of the fields above.

On the R. R. Boucher ranch 13 kilometers south of Chillicothe small springs (13) flow from Permian sandstones and siltstones. In 1969 a flow of 5.6 lps was measured, probably including some surface runoff. In 1977 the discharge was 0.13 lps. Waterfowl still frequent the springs.

Big Springs (6) were six kilometers southwest of Medicine Mound on J. T. Vantine's farm. In 1884 M.D.L. Vantine settled here, among 42-meter-high cottonwoods. Cottonwood Creek at that time was a grassy swale with no channel, according to Mr. Vantine. Later a valley trench five meters deep advanced through the area, probably because the trees were removed. A 2.1-meter-long lynx once killed four dogs here. The springs dried up around 1937.

There was once a spring of gypseous water (7) at the north base of the Medicine Mounds, on Bill Neal's ranch. The Comanches drank the healing water and worshipped the mound spirit. The spring has not flowed since the 1930s.

Spring Creek still is the site of some very small springs (1) 13 kilometers southwest of Quanah. The 1977 discharge of 0.12 lps ran about 500 meters before disappearing in the canyon fringed with gypsum cliffs and cedar trees.

Ten kilometers southwest of Goodlett were **Summers Springs (14)**. In 1936 they produced 0.38 lps. Now a grove of hackberries and mesquites marks the dry site.

Beaver dam at Wormwood Springs.

Numerous other small springs, some formerly of good size, could be mentioned, but space does not permit it.

HARDIN COUNTY

As Hardin County does not have a great deal of topographic relief, except along the Neches River, it is not surprising that there are no large springs. Those that still flow are small or very small. The water issues from various Quaternary terrace formations, composed chiefly of sand.

Most of the county is in what is known as the Big thicket. In its primeval condition this tangle of trees, vines and shrubs was almost impenetrable. The Atakapans were able to make their way through it by canoe. They and other Indians made good use of the country's fresh-water and mineral springs, and left much pottery and other artifacts as evidence.

Surrounding the springs, which often flowed into *baygalls* or swamps, was a great variety of plant and animal life. This has been greatly altered by man. The last of the huge virgin hardwoods were logged off around 1949. The carrier pigeons and parakeets were clubbed and shot into extinction in their roosts. Bears have almost vanished as a result of both hunting and destruction of their habitat. Still there remain many plants and animals which depend upon the springs and spring-fed creeks for their livelihood. The beautiful red maples, magnolias, muscadine and other grape vines, cypress, orchids, and insect-eating plants, all need plenty of water. Panthers,wild hogs, alligators, lizards, and snakes make their home here. Perhaps with the establishment of the Big Thicket National Park, some of the former wildlife species will be able to reestablish themselves.

Although there is not a very heavy use of groundwater in the county, water levels have declined. At Silsbee, for example, the water level sank 10 meters in the period of 1907 to 1962. As a result many springs have weakened or failed.

The quality of the groundwater has also been damaged by man's activities. Improper disposal of oil-

field brines has contaminated much shallow groundwater. Leaking well casings have allowed shallow fresh water to escape into deeper oil sands and saline-water aquifers. Heavy pumping in the Beaumont well field in the southeastern part of the county has caused salt water from the Gulf of Mexico to move inland. The spring waters are generally of a sodium bicarbonate type, fresh, moderately hard, and alkaline. The mineral springs may have high contents of iron, sodium, sulfate, or chloride. The water may be warmer than usual because of the high temperature gradient near the salt domes. The writer's field studies of the county's springs were made primarily during the period February 25 - March 2, 1977.

Near the cemetery one kilometer west of Votaw are **Votaw Springs (5)**. In a mixed hardwood and pine forest amid ferns and violets, they flowed 0.75 lps in 1977.

Just south of Bracken cemetery, three kilometers east of Honey Island, **Bracken Springs (6)** still flow weakly into cypress-lined Indian Creek. The bear-hunting Brackens built a cabin here in the 1840s, no doubt because of the springs.

At the old McNeely or McKinney cemetery ten kilometers north of Kountze several very small springs (7) flow from river terrace sand in a wood. In 1832, when settlers first arrived here, the springs were much stronger. Many wells nearby have lowered the groundwater table.

Three kilometers southwest of Kountze, near the old Hardin cemetery, very small springs (1) still flow from Montgomery sand. They were probably much larger and a major attraction to the early settlers who came in the 1830s. Numerous oil wells here have probably contributed to the failure of these springs.

Spring-fed Mill Creek northwest of Silsbee should also be mentioned. On March 2, 1977, there was a flow of 3.2 lps at the Highway 418 crossing.

Similarly, there are still seeps (8) just south of the Hooks cemetery, nine kilometers southeast of Kountze. This location was settled in the 1850s.

In a hilly sand terrace near the Neches River in southeastern Hardin County are **Meadows Springs (9)**, at latitude 30°16' and longitude 94°12'. Here two springs feed two small lakes. Flowing from beds of ferns and plantains, they produced 0.55 lps in 1977. According to owner C. E. Meadows, the Bumstead family settled here in the 1830s and planted four stately evangeline oaks. On a large beech tree at the springs may still be seen Indian carvings of a cow and a snake. The water is now piped to two homes.

In 1833 Concord, one kilometer east of Loeb on Pine Island Bayou, was the head of navigation. There were also good springs (10) here, which are still remembered by some residents. In 1977, however, they had been reduced to a flow of 0.06 lps.

Undoubtedly the most interesting springs in the county are **Sour Springs (2)**, two kilometers north of Sour Lake. Also called **Jackson Chalybeate Springs**, a variety of mineral springs are associated with the underlying salt and oil dome. Springs and oil seeps were present here many thousands of years ago. Fossil bones and teeth of Pleistocene mammals have been found in asphalt pits around the sour lake. Calling the place Medicine Lake, the Karankawas, Hais, and other Indians came under a sort of truce to apply the mud to skin sores and to drink the water. Jesuit missionaries in the eighteenth century are reported to have stopped here.

As early as 1835 settlers began using the springs, which were classed as "soda, tar, and sulfur" springs. The tar was bottled and sold as axle grease and as a balm for rheumatism. In 1857 Frederick Olmsted wrote:

> Near the western limit of Jefferson County is the odd natural phenomenon of a "fountain of lemonade." The supply is abundant, and a barrack has been built for summer visitors, who frequent the spring for the relief of every variety of disease — a cure, provided the use of the waters be sufficiently persevered in, being guaranteed by the proprietor. There are certainly, attractions in the cool shade, the gulf-breeze, the agreeable beverage, and the limpid bath, that should draw a throng, were the spot made accessible. There are two springs of cold, clear, acid, slightly astringent water, boiling with the outburst of an inflammable gas, having a slight odor of sulphuretted hydrogen. The overflow forms a pond of an acre in extent, which gives the locality its name of "Sour Lake." Upon the banks and bottom is a deposit of sulphur. The approach to the rude bathing houses is over a boggy margin, sending up a strong bituminous odor, upon pools in which rises a dense brown, transparent liquid, described as having the properties of the Persian and Italian naphthas.

In 1863 Sam Houston treated an old leg wound at Sour Springs. Around 1880 seven shallow wells were dug at the springs, where seven different types of water were said to be available. They ranged from sweet to bitter, sour, or acid, some tasting like "lemonade," and one very laxative.

Oil exploration began in 1896. By 1929 so much oil, gas, salt, and water had been removed that an area 60 meters in diameter collapsed and sank 27 meters. Two sweet gum trees and a boiler disappeared into the depths, forming the present Sour Lake, although a smaller lake existed here formerly. After a similar collapse in 1913 the springs ceased flowing for a time.

A former small lake with a pine-covered island at Sour Springs is now dry. The remnants of the swimming pool, mud baths, and shallow wells may still be seen. A historical marker is present on Highway 105 tc the south. In 1977 a flow of 0.74 liter per second issuec

from the sand. An analysis of the water from Sour Lake, into which the springs flow, is shown in the table of Selected Chemical Analyses. Although this analysis shows the general type of water present, the minerals have been concentrated by evaporation. The total dissolved solids content of the spring water is reported to have ranged from 153 to 1,640 milligrams per liter, as compared with 7,110 in the lake water.

Saratoga Springs (4) were discovered by white men in the 1850s when some hogs became covered with oil from an oil spring. A bathhouse was built over the sulfur springs, whose water was valued for treatment of ulcers and arthritis. It contained too much magnesium, however, and caused diarrhea. Around 1900, with the development of the Saratoga oil field, the mineral springs dried up. Later a hot flowing well supplied water for a swimming pool. Fresh-water springs which were probably used by early residents still flowed 0.30 lps in 1977 one kilometer south of the cemetery.

Two kilometers north of Batson there were formerly asphalt pits, oil seeps, and the smell of gas (3). The Atakapans came to the salt lake here to treat skin ailments. The seeps were often on fire after white settlers arrived. According to Robert Yust, who lives at the site, the seeps have not flowed since 1925.

HARRIS COUNTY

The springs of Harris County issue chiefly from Quaternary sands and silts, including the Willis, Bentley, Montgomery, and Beaumont formations. These beds dip toward the southeast at 4 to 7 meters per kilometer. Some springs also appear in river terrace sands along the major streams.

Harris County was occupied for thousands of years by the Karankawa Indians and their ancestors. Shell middens, pottery, and bone fish hooks have been found along Cedar Bayou just above its mouth. Radiocarbon dates from another archeological site in Galena Park indicate that it was occupied at least 3,350 years ago. This age should be corrected to about 3,650 years because there was less Carbon 14 in the atmosphere in the past. Probably long before this these early Americans made much use of the numerous springs which flowed at that time in the area.

Gideon Linecum remarked in 1835 that "Spring Creek abounds with good springs and timber." Young (1913) commented that at one time there was very good fishing on Buffalo and White Oak Bayou. Even flounders and porpoises were sometimes caught here. He described many swimming holes with pure white sand bottoms and clean and limpid water, with water lilies. In his words, "Houston has absolutely ruined

Hobart Lee at the remains of the swimming pool, Sour Springs.

Buffalo Bayou" and filled it with dirt and grease. Since 1913 much has been done to beautify the bayou. Azaleas grow at some of the springs. But at others such as Beauchamps Springs old automobile tires and other trash still litter the ground.

Wildlife was plentiful in the early days. Prairie chickens were shot by the thousands for sport only, and left for the buzzards. Many other animals and plants that lived around the springs are of course gone now.

Several older residents of the county remember how conditions were in the early 1900s. G. W. Brautigam of Tomball used to camp as a boy on Cypress Creek and White Oak Bayou when hauling cotton to Houston. He recalls excellent fishing and swimming on Spring and Cypress Creeks. At that time the area was covered with shallow windmill wells, he says, but they are all gone now as deep wells have pulled down the water table. He believes that pumping for rice irrigation has dried up many of the springs.

According to Tom Hillegeist of Spring Hills, the town of Spring around 1918 pumped water from Spring Creek. Arthur Price of Houston recalls "spending many happy days as a boy on the banks of Spring Creek swimming and fishing from 1914 to 1916. The creek "had many springs on the banks, which were cold and clear." He also states that as early as 1900 the International Great Northern Railroad (now the Missouri Pacific) used water from Spring Creek.

The testimony of these long-time residents is backed up by stream-flow measurements made by the U. S. Geological Survey. The graph shown in the section entitled "The Decline of Texas Springs" illustrates the decline in the minimum discharge (spring flow) of Spring Creek at Spring. It is obvious that the minimum discharge in recent years is much lower than that in the 1940s.

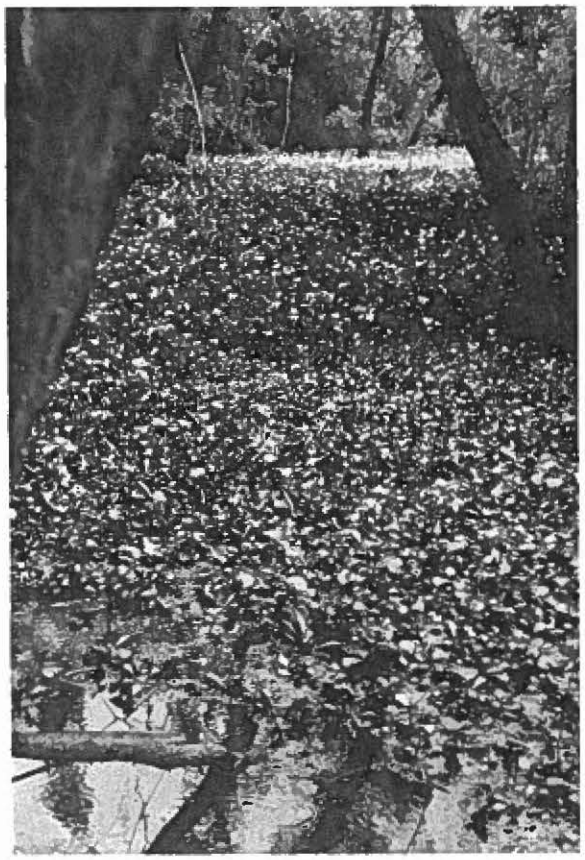
The many flowing wells drilled around the turn of the century wasted much groundwater. Some, such as Hot Wells at 24,815 Hempstead Road, still flow. But

heavy pumping for municipal, industrial, and irrigation use has been the final blow. Because of the very sizeable groundwater withdrawals in the Houston district, the water level in the formations mentioned above (also called the Chicot aquifer) had declined as much as 100 meters by 1970. As a result, most of the former springs have dried up. But some, fed by perched water tables, still trickle weakly. Some are now recharged by waste water from lawn irrigation and other sources.

The great drawdown in the water table has reversed the regional hydraulic gradient. Now, instead of fresh water moving out to sea, salt water is moving inland at about 100 meters per year and contaminating the groundwater. In addition, the heavy groundwater withdrawals had caused land subsidence of as much as 2.6 meters by 1973. This causes cracking of buildings and pipelines and increased flooding by high tides.

The springs' water is usually of a sodium bicarbonate type, fresh, soft, and acid. The content of silica or iron may be high. Most of the writer's field studies were made during the period April 8 - 13, 1978.

In 1836 when the town of Houston was laid out 10 kilometers upstream from the port of Harrisburg on Buffalo Bayou, a newspaper advertised (Looscan, 1914):



Water hyacinths in slough below Beauchamps Springs.

> There is no place in Texas more healthy, having an abundance of excellent spring water, and enjoying the sea breeze in all its freshness. No place in Texas possesses so many advantages for building, having pine, oak, cedar, and ash in inexhaustible quantities; also the tall and beautiful magnolia grows in abundance. In the vicinity are fine quarries of stone.

The writer of this description no doubt allowed himself to be carried away by his enthusiasm, as there is very little building stone near Houston. However, he was most likely right about the springs. At that time, before any wells had been drilled in the area, there were a large number of springs here.

Beauchamps Springs (1) are on White Oak Bayou. The name is French for "beautiful fields." In recent years there has been a tendency to drop the "s" from Beauchamps, but the writer will retain the original spelling. In 1746 Joaquin Orobio y Bazterra may have stopped here on his journey from Goliad to Nacogdoches. These were Houston's most important springs in early days. The largest and most convenient group was those which flowed in a draw at the foot of Johnson Street south of White Oak Bayou. This section is still called the Beauchamps Springs Subdivision. The springs are now beneath Interstate 10, but about 0.08 liter per second still trickled from a drain on April 11, 1978.

A smaller group of Beauchamps Springs seeps from Beaumont sand and small gravel on the north side of White Oak Bayou at the foot of Beauchamps Street. They issue at the base of a steep bluff in White Oak Park at an elevation of 10 meters above sea level. The discharge was 0.06 lps on May 24, 1975 and 0.03 on April 9, 1978. The water feeds a ½ - hectare pond covered with water hyacinths and fringed with water pennywort, water primroses, and marsh purslane. The site is shaded by large cottonwoods and grapevines.

In 1838 Beauchamps Springs were described as an "inexhaustible supply of pure cold and wholesome water." The water was sold in town at 75¢ for a 30 - gallon barrel. That year a meeting was held at the springs for the purpose of organizing a Houston water works company. The company, however, did not materialize until 40 years later. During the Civil War the Confederate forces had a campsite at the springs, according to Frank E. Tritico, chairman of the Harris County Historical Commission. In the early 1900s there was a popular swimming hole on White Oak Bayou four blocks west of the springs, according to E.

A. "Squatty" Lyons, Jr., Harris County Commissioner.

In the 1840s a dam was built on Buffalo Bayou at the Preston Street bridge. This reservoir, which stood until 1887, also supplied water to the town of Houston. It was described as

> supplied from a portion of the Bayou that is pregnant with springs.

Springs along Buffalo Bayou and Spring Branch were probably the principal contributor of potable water to this reservoir. In a few years, however, the water was so fouled with refuse and wastes that it could no longer be used for drinking purposes.

S. O. Young described some of the springs which flowed in the downtown Houston area (10). On Smith Street between Texas and Prairie Streets there was a "very large spring overhung by a large oak tree" in which a school of minnows played. By 1913, when he wrote, the gully containing the spring had been filled. The spring water still seeps from the concrete channel lining on Buffalo Bayou 200 meters northwest, amid azaleas and cypress trees in a park.

Another downtown spring described by Young was at Preston and Louisiana Streets. It caused a standing mud hole on Louisiana Street. This area is now all covered with paved parking lots and buildings. But the springs still flowed from a drain 200 meters north at 0.45 lps on April 10, 1978. The site, in Beaumont sand, is shaded by willows and grapevines.

In 1838 a young bachelor by the name of John Herndon visited Houston. His diary includes the statement

> Rode out to Mrs. Smith's. . . . Returned by way of Holland's. Got some spring water and saw some ladies.

Smith Springs (7), to which he referred, were on the Obediance Smith survey, which covered several square miles on the south side of Buffalo Bayou in Houston. Two groups still discharge into Buffalo Bayou along Allen Parkway. On April 10, 1978, one poured 11 lps from Beaumont sand and shell deposits at Stanford Street. The other discharged 0.95 lps at Tirrell Street. Pennywort fringes the flow, shaded by willows. Red, pink, and white azaleas bloom in the park in spring. (See Plate 5, d).

In the 1920s, according to "Squatty" Lyons, two or three springs (6) flowed in a gully just west of Shepherd Drive and on the north side of Buffalo Bayou in Houston. Nail kegs and barrels were sunk into these springs to facilitate obtaining water from them. Now dry, the site is on the grounds of the De Pelchin Faith Home. The barrels are buried beneath silt, leaves, and other debris.

In the Spring Branch community northwest of Houston numerous very small springs (3) issue from Beaumont silt and shell deposits. At the site of the 1865 Spring Branch school at 1,700 Campbell Road there was a discharge of 0.25 lps on Spring Branch among canna plants on April 9, 1978.

On Voss Road just north of Interstate 10 was Karl Kolbe's 1830 farm on Briar Creek, a tributary of Spring Branch. Kolbe was no doubt attracted by the springs (4), in this vicinity, which still produced a discharge of 10 lps on April 9, 1978, from Beaumont silt and shell deposits. The aquifer is probably replenished by waste water from lawn watering. The site is decorated with grapevines and Spanish moss. On Spring Branch one kilometer east of here was a "wonderful swimming hole," according to "Squatty" Lyons. It is now largely overgrown with brush and vines.

The importance of Spring Creek in early days is indicated by its appearance on J. H. Young's 1835 *New Map of Texas with Contiguous American and Mexican States*. Thirteen kilometers north-northwest of Cypress the settlement of New Kentucky thrived from 1831 to 1840 on Spring Creek. The early residents depended upon nearby springs (11) from Willis sand for their water supply. One of the **New Kentucky Springs** was just east of the community, now on Coy Killion's property. According to B. M. Gray, who lives here, the springs stopped flowing around 1923. Some seeps are still present. Spring Creek discharged 10 lps just north of New Kentucky on April 10, 1978. Soft-shell turtles live in the creek. A park and historical monument now mark the site of New Kentucky.

On Floridel Nichols' property 1.5 kilometers farther east are **Nichols' Springs (12)**. Many very small springs produce a discharge of 1.3 lps in a draw on the south side of Spring Creek. Originating in Willis sand, the water contains much iron. Violets and sensitive ferns are abundant, shaded by birch trees.

Ten kilometers west-northwest of Spring in a new subdivision are some springs (13) on a small branch of Willow Creek. They appear partially on Jerry Brooks' property at 24,214 Creekview Drive. Issuing from Montgomery sand in a wood, they are reported never to have failed. The son of Anthony McHale, a nearby resident, has caught large catfish and bass in the creek.

Klein Springs (16) are ten kilometers west-southwest of Spring on the Spring-Cypress road, on W.

F. Halley's farm. According to Dr. John Klein, a nearby resident and writer, the Klein settlement began here in 1848. The Sellars store was at the springs. They issued from Montgomery silt with many iron concretions at about 0.72 lps on April 11, 1978. The pools, containing duckweed, pennywort, and water primrose, were home to a family of ducks and ducklings. Probably the flow formerly continued down Spring Gully past Klein cemetery, 0.6 kilometer downstream, but on this date, even after rains, the channel here was dry except for some standing water. Many wells pump nearby.

Magnolia Garden Springs (15) are four kilometers northeast of Sheldon along the San Jacinto River. At Martha Dempsey's Good Times marina several very small springs trickle from Deweyville sand, including one which flows 0.15 lps from a pipe. Near the entrance to the nearby Magnolia Gardens marina, according to Jean Manson, springs flowed until about 1923. They are quite dry now. Very small springs are said to feed Simms Lake, across the river and 0.6 kilometer farther east. This formerly popular swimming hole is now closed to the public.

At Beaumont Place northeast of Houston, near the intersection of Highways 90 and 526, is another Spring Gully. The channel is now a drainage ditch into which very small springs and seeps (14) drain from Beaumont silt and sand.

Eight kilometers west of La Porte is Willow Springs Bayou, also called Willow Springs Gully or Ditch. **Willow Springs (8)** are chiefly between North L Street and Spencer Road. On April 9, 1978, the discharge of Willow Springs Bayou at North L Street was 0.18 lps, and at Spencer Road it was 0.70 lps. Many willows still fringe the channel, along with cattails.

A third Spring Gully is located eight kilometers southwest of La Porte. Springs (9) in Beaumont silt produced a discharge of about 0.18 lps in 1978 in the gully at the Red Bluff road crossing. Cottonmouths hide here among the willows and cattails.

HARRISON COUNTY

Harrison County is endowed with numerous springs of all types, some highly mineralized and valued for their healing properties. Most appear to be flowing as strongly as ever, because there has been little demand on the groundwater reservoirs. However, water levels in the artesian sands are declining as much as 4.6 meters per year in some areas. Most of the Caddo Indian villages were located at springs. Early French and Spanish explorers, some over 400 years ago, visited many of the same springs that can be seen today. The New Madrid earthquake of 1811 - 1812, which enlarged Caddo Lake, may have affected the flow of some springs. In general, however, the water-bearing formations were not greatly affected by the quake.

Most of the spring waters of the county issue from Eocene sands. They are usually fresh, soft, and acid, being of the sodium bicarbonate type. The iron content is often very high. Mineralized waters may also be high in aluminum and sulfate, may be slightly saline, and can be very hard. The analyses shown for 1942 in the table of Selected Chemical Analyses are probably too low in dissolved-solids content, perhaps because of high rainfall at the time the samples were collected. Most of the writer's field studies were made on January 23 - 28, 1976.

It was around **Locke Springs (1)** that the community of Marshall first appeared. In 1831 there were at least 20 springs flowing from the Reklaw sand near the intersection of Franklin and Houston Streets and up the hill toward the courthouse. In early times water was hauled from these springs in barrels to fill the cisterns on the town square. Most of the springs have now been paved over, but the remaining ones still flowed 1.4 liters per second in 1976.

Hynson Springs (10), also known as **Marshall, Noonday Camp**, and **Iron Springs**, are six kilometers north of Hallsville. They became very popular as a health resort about 1851. The waters are highly mineralized, containing much iron, sulfur, aluminum, and lithium. Originally there were said to be over 100 springs flowing from Queen City sand. Now not more than 20 can be found, possibly because the water table has fallen. During the Civil War the water from the springs was used in a leather-tanning factory. From 1891 to 1905 the large Hotel Randell accommodated thousands of visitors to the springs. Today there are an open-air auditorium and a number of cabins, but everything is in a sad state of disrepair. A historical marker is located at the springs. The discharge record, in liters per second, is as follows:

Jan. 28, 1942	0.13	
Jul. 21, 1964	0.06	
Jan. 27, 1976	0.13 (main spring)	1.6 (all springs)

Rock Springs (7) are just east of the Rock Springs church on Highway 449 about 13 kilometers west of Marshall. This and several other springs upstream flowed 2.3 lps from the Queen City sand in 1976. The Frenchman Henri Joutel of La Salle's party may have stopped here for refreshment in 1687.

Mulberry Springs (9), nine kilometers south-southwest of Harleton, are 100 meters north of the

Mulberry Springs church. Formerly used by the church, they flowed 0.55 lps from Queen City sand in 1976.

Eleven kilometers west of Harleton and 500 meters west of the Bluff Springs cemetery are **Bluff Springs (8)**. Flowing 1.5 lps from Queen City sand in 1976, they were much used by early settlers. The 1867 Isaiah Davidson home was two kilometers south.

Chadd Springs (22) are eight kilometers northwest of Harleton on the property of John Chadd, the Fifth, and just west of Smyrna cemetery. Here Dr. John Chadd built a log cabin in 1846 and hunted bears in his spare time. Downstream (a few kilometers north) Stroud's water mill ground corn and sawed lumber. The mill is now beneath Lake of the Pines. The spring waters were once used by a school and church, and later were piped to the house. One spring was boxed and used to raise minnows, but it no longer flows. The combined spring flow from Queen City sand and gravel was 0.80 lps on January 19, 1978.

Montvale Springs (15), found with the assistance of Inez Hughes, the Harrison County historical authority, are five kilometers east of Harleton and immediately east of old Piney cemetery. They discharge from Wilcox sand at the base of some high hills in a wood. The springs were valued for their healthful properties, and in 1914 a resort was described here by Deussen. They were evidently well known before this time, however, as in 1882 the Marshall and Northwestern Railroad was built from Marshall to the springs. The discharge on March 7, 1976 was estimated to be 0.50 lps excluding surface runoff from rain at the time of observation. Bear Springs are similar small springs four kilometers south near Bear Springs church.

Coushatta Springs (6) are on the Louisiana state line about 11 kilometers north of Waskom. They include numerous springs flowing from the Wilcox sand on top of a bed of clay. In 1841, a party surveying the boundary between the Republic of Texas and the United States encountered them. They

> encamped at a spring of most delicious water on an old Caddo Indian trail leading from Caddo Prairie to the Coushatta Village.

The discharge of 3.2 lps on January 25, 1976, probably includes some surface runoff from preceding rains.

There are two **Rock Springs** in the county. The second **(2)** are immediately northeast of Scottsville in a park adjoining the cemetery. This was the spot where Reason Scott and his family built their home in 1834. The springs flowed 0.75 lps in 1976 from the southeast side of a hill of Carrizo sand. They are beautifully maintained, with one issuing from a drinking fountain and another in a gazebo. They flow into several small ponds crossed by a bridge. (See Plate 10, d). A historical marker is nearby.

Rogers Springs (3) were much used in times past. They are just north of the old Rogers store on Highway 80, about 17 kilometers east of Marshall. They flow from fine sand of the Wilcox formation in a wood containing large pine trees. Their flow remained constant (0.47 lps) in 1942 and 1976.

Six kilometers northwest of Waskom and just south of Jonesville are **Sulphur Springs (5)**. Also called **Big Springs**, they were the site of a Caddo village. The settlers of Jonesville in 1847 picked these springs as a likely spot for a town. They became very popular for outings in the 1880s. Now their flow supplies a small stock pond. The discharge of 1.9 lps measured on January 26, 1976, probably includes some surface runoff from preceding rains. The old Lindsey country store and museum are in Jonesville.

Stricklin Springs (5) are 10 kilometers southwest of Waskom, at the Stricklin Springs church. Flowing 0.35 lps from Wilcox sand in 1976, they were the reason that the church was located here.

Biff Springs (20) are at the site of old Elysian Fields (two kilometers east of the present town). An Indian village was located here when Major Edward Smith arrived in 1817. Later the springs were a stop on the mail route from San Augustine to Port Caddo. A cotton gin was located 100 meters southwest of the springs. They were formerly walled up in a rectangular brick trough. Now they are numerous seeps from Wilcox fine sand in a one-hectare swampy area covered with water shields, soft rushes, and spikerushes.

Thirteen kilometers south of Marshall are the best-known and most attractive springs in the county, **Roseborough Springs (14)**. Here seven springs formerly flowed from Wilcox sand, although most must be pumped now. Long before the coming of the Europeans the Caddoes knew the value of these springs for treatment of various ailments. About 1840 early settlers began to use them. As may be seen in the table of Selected Chemical Analyses, the waters contain much iron, magnesium, and sulfate. They also contain 17 milligrams of aluminum per liter. The water from some of the springs is covered with a thick foam which is reported to be excellent for treatment of skin disease. It is claimed that dogs which swim in the water are not bothered by ticks. Also, (this has not been proven) the waters have birth-control powers.

People formerly came long distances by train to

Gazebo at Roseborough Springs.

Marshall and then by hack to the springs hotel to drink and bathe in the waters. The grounds now belong to the Smith Steel Castings Company of Marshall, which has done a commendable job of maintaining the pavilion, gazebo, swimming pool, and springs. There is still a great demand for the water, which is sold for 25¢ per gallon. The discharge of the main springs was 0.31 lps in 1942, and for all of the springs 1.4 lps in 1976.

Seventeen kilometers southwest of Marshall on Highway 43 and 200 meters west of the Cave Springs church are **Cave Springs (13)**. In the 1860s many early residents of the area obtained water here. In 1976 they flowed 0.14 lps from Wilcox sand. The similar small **Ash Springs** are near Ash Springs church five kilometers northwest.

Gum Springs (12) are on Oscar Heim's place, six kilometers southeast of Longview on Highway 968, 300 meters south of the Gum Springs church. Flowing from Reklaw sand, the springs were named for a large gum tree, since cut down. For many years a school used the water, which still flowed at 0.06 lps in 1976.

Nelson Springs (11), three kilometers southwest of Hallsville, were reported as good soft-water springs in 1914 by Deussen. Flowing from Reklaw sand, the main spring is now housed in an attractive gazebo or spring house. The springs were much used by early settlers. About one kilometer to the east the privately-built Fort Crawford was erected as protection from the Cherokees. The flow has declined from 0.13 lps in 1914 (Deussen) to 0.06 in 1976.

Mason Springs (21) are eight kilometers east of Longview, just south of the T and P Railroad, and 200 meters southwest of the Mason Springs church. That they were very important in earlier times is attested to by their being depicted on several early maps. These include N.D. Thompson and Company's 1879 *Map of Texas*, A.W. Spaight's 1882 *Official map of the state of Texas*, and Rand McNally's 1883 *Map of Texas and Indian Territory*. Many springs appear in a large wooded swamp from Queen City sand. The iron-bearing water with its orange sediment flowed 0.62 lps on January 14, 1978.

HARTLEY COUNTY

In this county of friendly people and no locked gates, springs flow chiefly from Ogallala sand and caliche, and to a small extent from Triassic sandstone. Most are located along the larger streams, where there is adequate topographic relief. Along all of these streams where constantly flowing water formerly existed there is evidence that man lived for many thousands of years.

Plowing up of the grasslands did great harm to the recharge capacity of the soils. It also caused severe erosion and sedimentation damage. When the grasses which had only a fragile hold on the soil were removed, streams began to cut headward in valley trenches five meters or more deep. The sand removed was redeposited downstream, filling the once-deep, fish-filled pools and causing the stream channels to widen immensely. Ben Trujillo of Channing is very familiar with this problem. When his family came to the area in 1874, *Punta de Agua* (Source of Water) Creek at Highway 767 was deep, 15 meters wide, and had grassy meadows on each side. Now the channel is completely filled and is 500 meters wide, covering the entire valley.

Other factors caused damage to the groundwater reservoir. Flowing wells have wasted much water. Groundwater pumping for crop irrigation, however, is the primary offender. As a result groundwater tables are declining as much as one meter per year, and many springs have failed.

In former times the spring areas teemed with wildlife, including bison, deer, antelope, raccoons, wolves, and bobcats. With the failure of springs and other damage to their habitat, many of these animals can no longer survive in the county. Birds also often depend upon spring water. But pheasants, doves, ducks, lark buntings, and wild turkeys are doing reasonably well, using other water sources such as windmill tanks.

The county's spring waters are generally of a calcium bicarbonate type, fresh, very hard, and alkaline. The high fluoride content may be objectionable. The writer's field studies were made primarily during the period April 27 - May 2, 1977.

Gould (1907) stated that many creeks in the county, such as Tascosa and Cheyenne Creeks, were spring-fed at that time. Most of these springs have now dried up. Cottonwood Draw (2), about 18 kilometers south of Dalhart, was named for the cottonwoods which lined it. Now the cottonwoods, and the springs which fed them, are largely gone.

On lower *Rito Blanco* (White Valley) Creek a number of springs called the **XIT Springs (1)** emerge. They first appear on the Reynolds ranch 14 kilometers southwest of Hartley, and the flow increases to about 3.3 lps in winter where Rito Blanco (now often spelled Rita Blanca) Creek joins Punta de Agua Creek. In the summer the flow usually fails for three or four months because of irrigation pumping. Probably the flow was much larger and continuous and extended farther upstream in 1877 when a Mexican-American settlement was made at the junction of these creeks.

In 1890 the general headquarters of the 3-million-acre XIT ranch was established at one of the larger springs on Bland Burson's ranch. A lake was fed by this spring, and 16 hectares of alfalfa, apples, peaches, plums, pears, and grapes were irrigated. The ruins of the old headquarters still stand. In 1938 this particular spring produced 0.76 lps, but it no longer flows. It was popular for picnics and outings in the 1920s.

On the Proctor ranch, managed by Junior Hays, 23 kilometers west of Channing, are several very small springs. **Red Springs (8)** flow from gravel on top of Triassic clays 13 kilometers west of the ranch headquarters on the south side of Highway 767. Seven kilometers farther east, also on the south side of the highway, are the similar **Antelope Springs (9)**.

At the Houghton ranch headquarters, located at latitude 35°43' and longitude 102°46', are a group of excellent springs (7). Flowing 6.5 lps in winter, not including evaporation from several lakes which they supply, they are used to irrigate a garden and orchard. Grapevines and water cress surround the springs, and large catfish and bass inhabit the lakes. According to manager Marion Perkins the spring discharge slows down in summer because of irrigation pumping to the west. Smaller springs are located two and five kilometers northeast.

On the Spring Creek ranch, managed by Alvin Payne, several springs still flow. Those in the grove of trees at the headquarters (4), at latitude 35°39' and longitude 102°49', have essentially ceased flowing. But four kilometers southwest the **Spring Creek Springs (6)** still produce 0.65 lps in winter and somewhat less in summer. Snapping turtles may be seen here. Four kilometers farther west, on Minneosa Creek, are the **Hay Meadow Springs (5)**, and seven kilometers farther upstream are **Bull Springs (10)**. These springs on Minneosa Creek produce a winter flow of 0.16 lps among cottonwood trees, which run several kilometers into Oldham County. They dry up for several months in the summer.

On Punta de Agua Creek about seven kilometers downstream from its crossing of the New Mexico state line are the **Punta de Agua Springs (3)**. They rise on the Whiteaker ranch operated by Red Parker, at an

elevation of about 1,285 meters. Their flow increases to 3.5 liters per second, flowing downstream about 8 kilometers in winter, and much less in summer. Cottonwoods, cattails, willows, and salt cedar are abundant, and prairie dogs live nearby. Many Indian artifacts have been found here. Pedro Vial and his companions may have camped at these springs in 1793, en route from Saint Louis to Santa Fe. Seeps are also present on the upstream Beck ranch. Other small springs occur downstream. At the Highway 767 crossing about 10 lps was passing on May 3, 1977.

HASKELL COUNTY

Haskell County lies in the Rolling Red Plains, where Permian formations such as the Clear Fork and Lueders crop out, dipping gently toward the west-northwest. Some small springs issue from gypsum, sandstone, limestone, and dolomite in these formations. Large areas of the Permian are covered with deposits of Seymour sand and gravel. These are ancient stream deposits up to 21 meters thick. Unless otherwise noted, the stronger springs in the county pour from the Seymour at its contact with the underlying Permian rocks.

The usual spring vegetation includes willow, cottonwood, salt cedar, and hackberry trees, cattails, and rushes. Mesquite trees are found everywhere. Cedar trees are abundant in the redbed breaks.

A wide variety of animals frequented the springs and spring-fed lakes and streams in bygone days. Most are now gone. The buffalo slaughter started in Haskell County in 1875. Turkeys were shot by the hundreds in the trees where they roosted. Ducks and geese landed by the thousands on lakes and water holes teeming with fish.

But even if they had not been slaughtered, most of these animals could not survive in this area today. The water table has fallen and springs, streams, and lakes have dried up. Lakes have been filled with sediment from accelerated sheet erosion. Stream channels have been choked with sand from gully erosion.

In 1885-87, 1896, 1910, 1918, 1943, and 1952-56, droughts caused most springs to dry up temporarily. From 1919 to 1941 there was a decided increase in precipitation which rejuvenated many springs.

But the primary factor in the progressive weakening and failure of the springs has been irrigation pumping of ground water. It began in earnest around 1950, causing a drop in the water table in the Seymour formation of as much as 4.4 meters between 1952 and 1959. In 1956, discharge of groundwater, chiefly from wells, was four times the natural recharge to the groundwater reservoir. At that time 96 percent of the water use in the county was groundwater pumped for irrigation. Hence it was no surprise that many springs faltered and dried up. Since 1964 irrigation pumping has declined, partly because insufficient water remains for efficient use. But it is unlikely that dry springs will start flowing again.

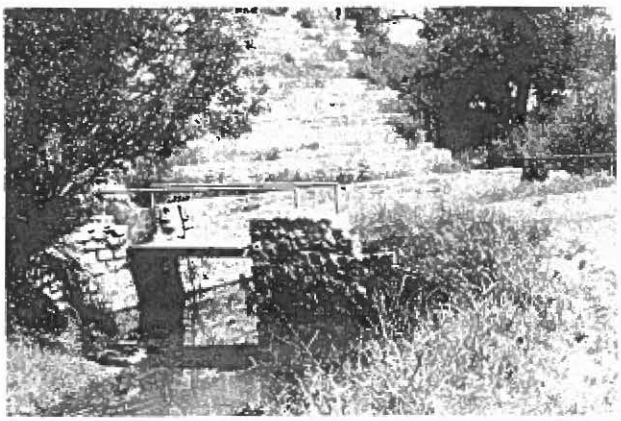
The Seymour formation spring water is normally of a calcium bicarbonate type, fresh, very hard, and alkaline. Springs from Permian formations usually are more mineralized. Contamination with sodium chloride has occurred in the past from improper brine-disposal methods in oil fields. Coliform organisms and nitrates from septic tanks and barnyards have also polluted some groundwater.

Most of the writer's field studies were made during the period September 7-12, 1979.

Rice Springs (2) are in the Haskell city park on the south side of town. In 1854 Capt. R.B. Marcy probably stopped here while exploring for locations for Indian reservations. Much later, the springs were named for cowboy Ryus Durrett. In 1884 they were known as **Malby Springs**, and later as **Haskell Springs**. The Haskell community was formerly known as Rice Springs.

This was a popular campsite with Indians. Many Indian graves have been found here, as well as a large pile of buffalo bones. In 1867 a posse chasing Comanches stopped for lunch at the springs. In 1875 the Mooar brothers, buffalo hunters, camped here. In 1881 a few Tonkawas still lived in teepees at Rice Springs. In 1885 the first school in the county was located nearby. Early settlers camped here, and in 1888 baptisms were held in the spring branch.

The water emerges from Seymour sand and gravel on Permian shale. On March 17, 1944, the discharge of slightly saline water was 0.63 liter per second. On



Amphitheater at Rice Springs.

September 7, 1979, it was 3.5 lps, at an elevation of 470 meters. The spring aquifer has received much recharge in recent years from watering of lawns and gardens in the city.

A rock amphitheatre has been built overlooking Rice Springs. Many birds chatter in the willow trees. Large turtles and minnows live in the pools. Dragonfiles and damsel flies dart among the yellow saw-leaf daisies in summer. Black soils nearby indicate that the springs and adjacent swamps were once more extensive.

Willow Pond Springs are very close to Rice Springs and have often been confused with them. Actually, according to Rex Felker, Haskell writer, Willow Pond Springs are about 300 meters east of Rice Springs, east of the fairgrounds. In 1885 Col. Thomas Tucker stopped here. On September 8, 1979, there was no flow here. But a few hundred meters downstream, just above the draw's junction with Rice Springs Branch, there was a flow of 0.06 lps. The site is almost impenetrable, covered with 2-meter-high tumbleweeds and willows.

Five kilometers west of Rule are a group of springs (4) in a gullied area in the bluff on the east side of the Double Mountain Fork of the Brazos. They pour out on Tommy Davis' ranch, feeding two stock ponds, and are used for irrigation. On March 20, 1944, the discharge of fresh water was 1.6 lps. On September 8, 1979, the flow was 0.61 lps. Pink ironweed flowers adorn the site. Similar springs flow on Mabel Overton's ranch four kilometers north-northwest of these springs.

There was formerly a Comanche campsite near the mouth of Tonk Creek (1), eight kilometers west of Rule. At that time Tonk Creek ran constantly to the Double Mountain Fork of the Brazos, fed by Cottonwood and other springs in Stonewall County. In 1867 a posse surprised the Comanche camp, killing many. On September 7, 1979, there were only a few seep-fed pools here.

Eleven kilometers northwest of Rule, on the west side of Double Mountain Fork, was a spring (5) on Tom Simpson's ranch. In the 1920s it was walled up and used by many area residents. On September 9, 1979, the water was 0.8 meter below the surface, but the spring usually flows in winter, according to Simpson. Many irrigation wells in the area to the west have taken their toll of the groundwater. Frogs and water striders reside in the spring, shaded by hackberry and huge willow trees.

Cook Springs (6) are 10 kilometers north-northwest of Rule on Frank Ashley's ranch. Many stone projectile points and tools found here indicate that this was a popular living area in prehistoric times. Cook Springs school was first located here, moving to two other locations later. The springs feed a 2-hectare fishing and swimming lake. On September 9, 1979, the discharge was 2.6 lps, of which about half evaporated in the lake. Wild plum thickets are numerous here.

McGregor Springs (7) are 13 kilometers west of O'Brien on O.B. Ratliff's ranch, managed by R.L. Anderson. On September 9, 1979, 1.7 lps was feeding two stock tanks. Water cress and pink ironweed flowers thrive at the springs. Many irrigation wells to the east have affected the spring flow. Anderson has counted 28 springs in this vicinity. One was probably **O J Spring**, which was much used in early days by cattle on drives.

Near Weinert on Lake Creek was the old Lake Creek community (9). In prehistoric times this was also an Indian village. Upper Lake Creek was once fed by a chain of seep-fed lakes and swamps. Now, with a falling water table, most of the lakes have been filled with sediment and are farmed across. Many irrigation wells pump to the west. On September 10, 1979, there were only pools of surface runoff water in Lake Creek at this point. The channel has largely been filled with sand.

Just west of Highway 277 and south of the Knox County line was Big Lake (10), where buffalo hunters camped. The area is now on Grace Reid's and T.J. Brueggeman's farms. As the water table fell, Big Lake shrank and became two lakes, Reid and Griffin Lakes. The 20-centimeter rains of August, 1978, swelled the lakes, but only temporarily and not to their original levels.

On Wild Horse Creek in the northeast corner of the county were some Indian campsites (8) on C.T. West's and Floyd Bowman's farms. Evidently there was running water here at that time. The creek has been dry at least since 1935, according to West. Now only muddy runoff water collects in pools after rains. Hackberry trees fringe the channel.

Willow Springs (11) were on Millers Creek about 19 kilometers northeast of Haskell. The site is on Dr. J.G. Vaughter's ranch, leased by Carl Rueffer. The springs were portrayed on several military maps, including Lt. Pratt's 1872 *Sketch accompanying report*, Lt. Col. George Buell's *March made during April 1873*, and Buell's 1874 *March from Fort Griffin*. Buell called them "never failing water". But they have essentially failed now. Some seeps are still present. According to Rueffer, Millers Creek at this place runs after rains for about 3 weeks, whereas it dries up quickly upstream. The water trickles from Seymour sand and gravel on Permian shales. The site now supports numerous hackberry, elm, mesquite and cedar trees, and yellow sawleaf daisies.

Buffalo Springs (13) were in southeastern Haskell County at latitude 33°03' and longitude 99°30' on Mrs. S.G. Cobb's property. Here the old Cobb community grew up in the 1880s. Buffalo "College", a one-room school, was near the springs, according to R.H. Cobb. According to Glen Cobb, the springs once watered 100 head of cattle, along with antelope, turkeys, and wild hogs. Wild hogs still frequent the vicinity. The springs poured from Lueders limestone downstream from an old earth and masonry tank. Probably some trickled above the tank also. They have been dry since the 1940s. Purple ironweed, yellow ragwort, and white snow-on-the-mountain flowers decorate the scene in a mesquite-filled pasture.

Blue Hole Springs (16) were 16 kilometers southeast of Haskell near the mouth of Mule Creek. Here the M O ranch had cattle pens in the 1880s. Many area residents obtained water from the springs. Since 1953 they have been beneath the waters of Lake Stamford.

On Alex McLennan's ranch was a spring (15) in southeastern Haskell County at latitude 32°59' and longitude 99°33'. Many area residents hauled water from the curbed spring, which trickled from Lueders limestone. According to McLennan, it stopped running around 1919, but still seeps in wet weather.

Another spring (14) on the McLennan ranch is 16 kilometers east of Stamford. It is usually under water in California Creek about one kilometer south of the ranch house. According to McLennan, the spring, originally large enough to water 300 head of cattle, still flows.

Other small springs (17) emerged 10 kilometers east-northeast of Stamford on Arche Pardue's lease. Originally forming Spring Creek, they are now only wet-weather seeps.

Gyp Springs (3) are 11 kilometers south of Rule on Richard Mathis' ranch. The Mackenzie trail passed this spot from 1874 to 1900. The water, containing considerable algal growths, feeds Gyp Creek. On September 8, 1979, the discharge was 1.7 lps. Frogs, minnows; and blue damsel flies make their home among the salt cedars, cattails, and rushes. Other former springs nearby are now only seeps.

HAYS COUNTY

Hays County is very well watered, containing among many others the second largest springs in Texas, San Marcos Springs. These springs attracted the early Americans of this area. During the excavations for the old fish hatchery a short distance downstream from San Marcos Springs, many projectile points and other artifacts were found. Angostura points found in the area indicate that Paleo-Indian people were using the springs at least 8,000 years ago. The Timmeron archeological site on Lone Man Creek, eight kilometers east of Wimberly, was recently excavated under the direction of Dr. W.R. Van der Veer of the University of Texas at San Antonio. Here a corn cob was found, which discloses that the Tonkawa Indians of the area were practicing farming at least 800 years ago.

Historical records indicate that there was a severe drought from 1856 to 1859, and that many livestock animals died from lack of water and food. As this was before any recorded measurements of spring discharge were made, it is not known to what extent this drought affected spring flows.

Lundelius and Slaughter (1971) described several species of shrimp, springtails, blind salamanders, and flatworms which live in the Edwards aquifer groundwater beneath the county. Glen Longley of the Aquatic Station at Southwest Texas State University in San Marcos has also found several species of copepods, amphipods, isopods, beetles, snails, and other organisms in these underground waters. All of these animals are blind and lack skin pigmentation. Some are carried from the aquifer in spring flows and are soon devoured by predaceous fish. Two unique fish which live in the spring waters, the fountain darter and San Marcos gambusia, last seen in 1974, are endangered. The San Marcos salamander is known only from San Marcos Springs. This unusual fauna can live nowhere else, and will be lost if groundwater levels continue to be drawn down.

Similarly, some plants are highly dependent upon the springs' environment. Texas wild rice, for example, does not exist outside of the vicinity of San Marcos Springs. It has recently been placed on the endangered list.

The county's spring waters are mostly of the calcium bicarbonate type, fresh, very hard, and alkaline. Most of the writer's field studies were made on August 12-17, 1975.

Jacob's Well (14), a moderately large spring five kilometers north-northwest of Wimberly, is the source of Cypress Creek. Here the Glen Rose limestone has been faulted against impermeable beds and the water has been forced upward along the fault. It has dissolved out a sloping shaft about three meters in diameter and 40 meters deep. It was formerly a haunt of scuba divers, but since several have lost their lives here diving is no longer permitted. The spring has now been acquired by

the Woodcreek resort development. Discharge measurements, in lps, follow:

Aug. 5, 1924	170	Jan. 6, 1955	68
Oct. 28, 1937	170	Apr. 4, 1962	120
Dec. 6, 1937	82	Jul. 10, 1974	100

Dripping Springs were depicted on Johnson's and Ward's 1863 *New map of the state of Texas*. There are several Dripping Springs which are said to have given their name to the town of Dripping Springs. All flow from the Glen Rose limestone. One (10), three kilometers west of town and 300 meters south of Highway 290, is in a very pleasing setting, with a waterfall, travertine formations, ferns, and massive limestone boulders. In 1975 it poured out 1.9 lps. Another (9) flowed 0.31 lps in 1975 in Dripping Springs, just north of old Highway 290. There are several other springs in town, including **Walnut Springs**, shown on an 1884 Geological Survey topographic map. When Mr. Fawcett and others built their cabins here around 1849, the springs were an important source of water. For thousands of years before that they were used by early Americans.

Dead Man's Hole and its springs (11), about 14 kilometers north-northwest of Dripping Springs on Bert Hurlbut's ranch, is a really delightful spot. Because of its remote location and the difficulty of reaching it, it has been preserved largely as it was thousands of years ago when early Americans lived here. It was however, well known to early settlers and Comstock depicted it on his 1890 map.

Geologically it is very similar to Hamilton Pool and Westcave and Levi Springs in Travis County, all of which are on small tributaries to the Pedernales River. The springs flow chiefly from the Hensel sand into a stream which plunges over a resistant Cow Creek limestone cliff into a pool about 75 meters in diameter. The underlying Hammett shale has been removed by erosion so that there is a large overhanging cliff and a rock shelter behind the falls. Evaporation of the water falling and dripping over the cliffs has formed many stalactites. Large limestone boulders and cypress trees abound. (See Plate 4,a).

On August 16, 1975, the discharge was 24 lps, and on May 1, 1978, after much dry weather, 2.9 lps. Pondweed and water cress fringe the spring waters, and maidenhair ferns cling to the rock walls. Large fish live in the pool, black rock squirrels dart on the cliffs, and a cloud of swallows whirls overhead.

Ben McCullough Spring (14) is in the southwest corner of Camp Ben McCulloch, two kilometers east of Driftwood. It discharged 0.76 lps from three one-inch pipes in a wall close to Onion Creek in 1975. During the drought in 1955 the flow was 0.63 lps. For many years starting in 1896 the camp was used for annual reunions of Confederate veterans. It has become a favorite location for gatherings of the area residents.

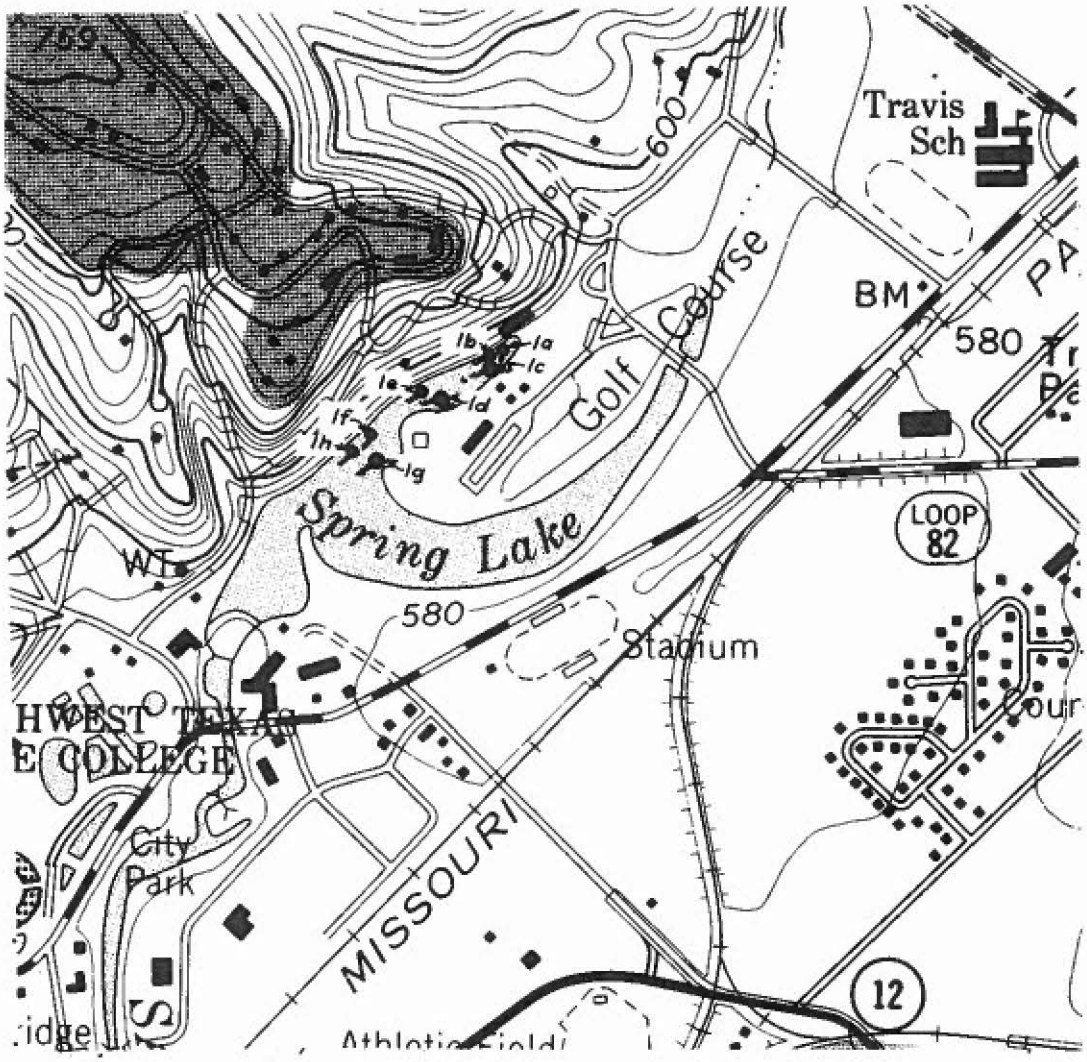
Rooster Springs (8), nine kilometers east of Dripping Springs on Highway 290, were once a stage stop on the Austin-to-Blanco road. Rising from Glen Rose limestone, their flow has now been greatly diminished by the pumping of a nearby well. In 1975 the springs supplied a stock tank downstream at the rate of 0.13 lps.

Capt Springs (7) are nine kilometers northeast of Driftwood just south of Highway 1826 and on the south side of Bear Creek. The springs were formerly walled up but now issue from several other openings nearby. They are located at the base of a rock bluff on a fault, through which the water rises under artesian pressure from the Edwards and associated limestones. In 1851 Mr. Capt built a small grist mill here, which was washed away in 1867. The springs provided household water for the nearby settlers, but the mill's water power was furnished by Bear Creek. Although they dried up in the summer of 1951, they were again flowing 2.5 lps in 1975.

The two **Uhland Springs** issue from high terrace deposits called Leona gravel. Both were formerly used as a water supply by the town of Uhland, which now obtains its water from Kyle. The first group (3) is 1.5 kilometers west-southwest of Uhland in a willow grove on Mrs. Horace Cochran's farm. On August 17, 1975, it produced 0.94 lps, but on May 1, 1978, after much dry weather, there was only a seep.

The second group, also called **Pecan Springs (4)**, are four kilometers west of Uhland on Dr. M.D. Heatly's property. They are probably the springs which the Spanish explorer Domingo Ramon called **San Pedro del Nogal** (St. Peter of the Pecan) in 1716. Two pecan trees still survive here. In the 1920s a rectangular pit 12 meters deep was dug and walled to facilitate pumping water from the springs. Containing much water cress and pennywort, the water now supplies two houses and two lakes, from which it is taken for crop irrigation. The discharge was 2.5 lps on February 8, 1946, 1.9 on August 17, 1975, and 0.18 on May 1, 1978. According to Dr. Heatly, the flow has reached 6.0 lps at times. Many other springs trickle from Leona gravel in this area.

The moderately large **Sink Springs (2)** are five kilometers northeast of San Marcos on Mrs. Joe McGeath's property. They rise through a fault which crosses Sink Creek under artesian pressure from the Edwards limestones. The water pours into a small pond



Location of the various San Marcos Springs.

covered with tiny duckweed plants, whence it is pumped to the Bollman Industries wool-scouring plant. Formerly it also supplied several houses. According to Kyle Wright, manager of Bollman, the discharge decreased slightly during the 1950s drought, but was always adequate for the mill's requirements. On October 4, 1937, the flow was 50 lps. Edward Burleson settled here in 1849 and used the spring water. His stone house with a historical medallion still stands west of the springs.

San Marcos Springs (1), also known as **Saint Mark's** and more recently as **Aquarena Springs**, are three kilometers northeast of San Marcos. The Tonkawas called them **Canocanayesatetlo**, meaning *warm water*, although they are only very slightly warm.

Their artesian source is the Edwards and associated limestones along the San Marcos Springs fault, where an underground barrier of Austin chalk and Taylor marl forces the water to the surface. Some 200 springs leap from three large fissures and many smaller openings in the bottom of Spring Lake at an elevation of about 175 meters above sea level, giving birth to the San Marcos River. The sand boils formed by many of the springs, along with schools of large fish, may be viewed from glass-bottom boats. The accompanying map shows the locations of the various groups of springs. The three larger ones are **Weismuller (1c)**, **Installation** or **Pipe (1d)**, where the mermaids perform, and **Deep Hole Springs (1g)**, according to director of operations Scott McGehee. The more important other springs are called **Salt and Pepper (1a)**, **Cabomba, (1b**, named for the aquatic herb *Cabomba* or fanwort), **Cream of Wheat (1e)**, **Catfish Hotel (1f)**, and **Rio Grande Springs (1h)**. The tremendous discharge of the springs can best be seen where the water leaves the lake through two spillways. The one at the west end of the dam carries most of the flow and is very popular for swimming. (See Plate 1,d).

Guyton and Associates (1979) have estimated 55 to 60 percent of the flow of San Marcos Springs is water which flows past Comal Springs from the area to the west-southwest. The remaining water is from more

San Marcos Springs and park as seen from a cable car.