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BULLETIN 6111

A RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF THE MARATHON AREA, BREWSTER COUNTY, TEXAS

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United States Department of the Interior,
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A RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF THE MARATHON AREA, BREWSTER COUNTY, TEXAS

ABSTRACT

The Marathon area in West Texas occupies about 760 square miles in northeastern Brewster County. The economy of the area is dependent primarily upon ranching. The only town is Marathon, which had a population of 600 in 1960. The climate is semiarid, the average annual precipitation being about 18 inches.

The Marathon area is underlain chiefly by Paleozoic sedimentary rocks having a total thickness of about 21,000 feet. Prior to deposition of Permian rocks, the area was subjected to intense folding and faulting. Permian and Cretaceous rocks were subsequently deposited on the eroded surface of the older rocks. Uplift of the area formed the Marathon dome, the central part of which has been removed by erosion, thus exposing the older Paleozoic rocks in the present topographic basin.

The principal aquifers in the Marathon area are the Marathon limestone and the alluvial deposits. Smaller quantities of water are obtained from sandstones of Pennsylvanian age. The Marathon limestone, which yields as much as 300 gallons per minute to individual wells, is tapped by wells chiefly in the anticlinorial belts. The Marathon is downfolded to great depths in the synclinorial belts; consequently, ground water in these areas is obtained from the relatively shallow rocks of Pennsylvanian age.

The aquifers underlying the area are recharged chiefly by precipitation on the area. The annual recharge is estimated to be about 35,000 acre-feet. Ground water is discharged principally by underflow out of the area toward the Rio Grande. Discharge by springs is about 660 acre-feet per year, and discharge through wells is about 450 acre-feet. The amounts of discharge by underflow and evapotranspiration are not known.

Most of the ground water in the area is of good chemical quality except that it is hard. Some contamination by oil and gas and associated saline water has been noted in the vicinity of Marathon.

A RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF THE MARATHON AREA, BREWSTER COUNTY, TEXAS

INTRODUCTION

Purpose and Scope of Investigation

The reconnaissance of the ground-water resources of the Marathon area was begun in October 1956 as part of a cooperative program of the Texas Board of Water Engineers, the Commissioners Court of Brewster County, and the U. S. Geological Survey. Study was made of the occurrence, quantity, quality, and use of ground water in the Marathon area.

The geology of the area was taken almost entirely from the work of King (1937). The report contains King's geologic map of the Marathon area, slightly modified, and the discussion of the geologic formations exposed in the area is adapted largely from his work.

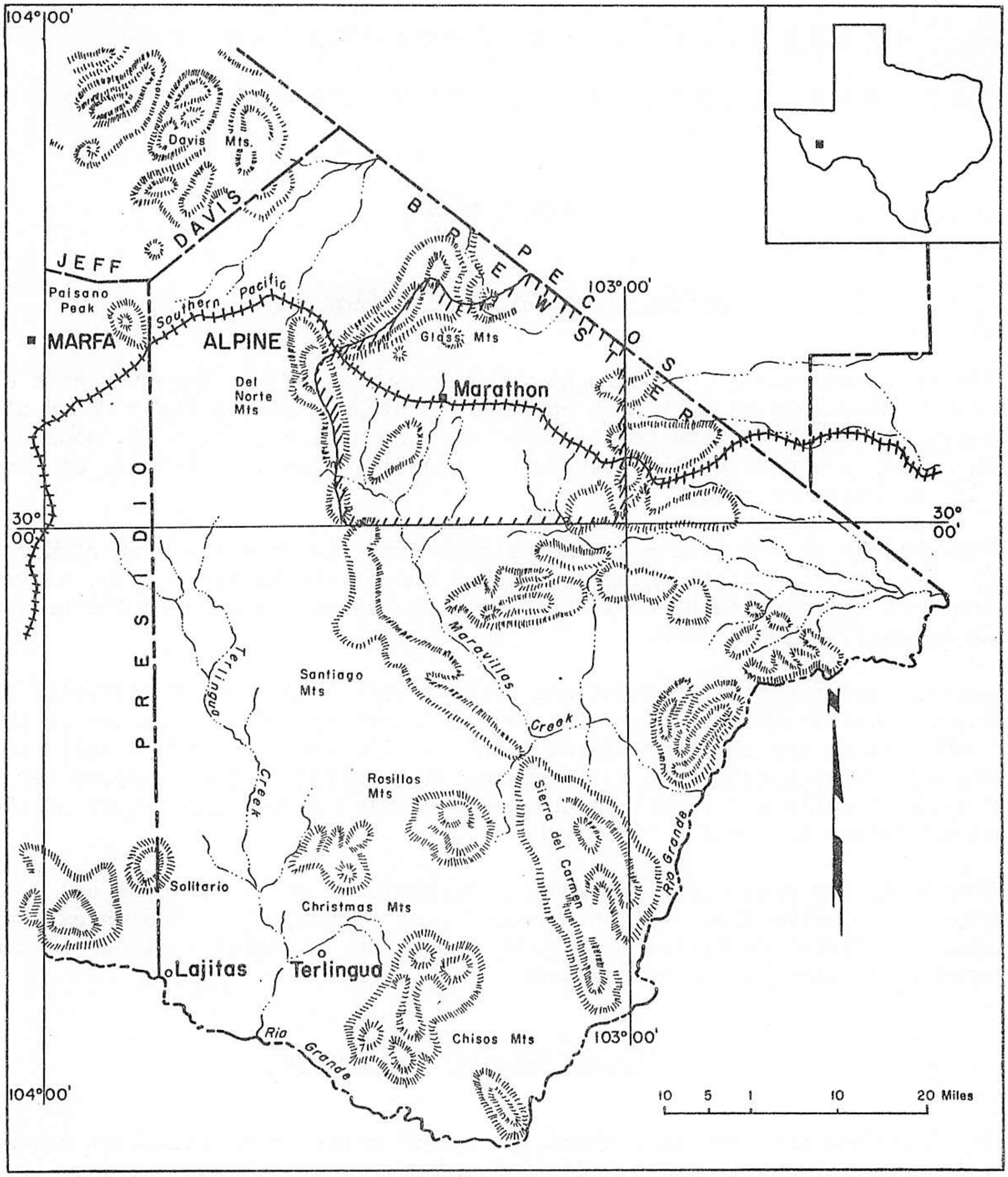
During the present investigation, records were collected of 313 wells and 11 springs, including logs of 3 wells (Tables 2 and 3). The locations of the wells and springs are shown on Plates 1 and 2. The altitudes of 38 wells in and near Marathon were established by instrumental leveling. Water samples were collected from 18 wells and 3 springs and were analyzed in the laboratory of the Geological Survey in Austin. (See Table 4.)

The study was made under the general supervision of A. N. Sayre and P. E. LaMoreaux, successive chiefs of the Ground Water Branch, U. S. Geological Survey, and under the direct supervision of R. W. Sundstrom, district engineer in charge of ground-water investigations in Texas.

Location and Economic Development

The Marathon area includes about 760 square miles in northeastern Brewster County in West Texas (Figure 1). It is bounded on the north and west by the boundaries of the drainage area of the Marathon basin, as shown on Plate 1; on the northeast and east by the Brewster-Pecos County line and the meridian of 103° west longitude; and on the south by the parallel of 30° north latitude. The town of Marathon is approximately in the center of the area.

The economy of Marathon, which had a population of 600 in 1960, is sustained mostly by stockraising (cattle in the lowlands, sheep and goats in the rugged



After Goldich, Elms, and Seward, 1949, p. 64

FIGURE 1.- Physiographic map of a part of Texas showing location of Marathon area

uplands) on the large ranches in the surrounding area. Farming is limited by the lack of suitable topography and soil and by insufficient rainfall.

Travel from east to west in the Marathon area is chiefly by way of U. S. Highway 90 and the Southern Pacific Railroad. U. S. Highway 385 leads north to Fort Stockton and south to Big Bend National Park. The few minor roads in the area are mainly private ranch roads. The town of Marathon is the shipping point for ores mined in southern Brewster County and in the northwestern part of the Mexican State of Coahuila.

Previous Investigations

The Marathon area has long been considered a classic area for geologic studies, and the geology is well known; however, no investigations have been made of the occurrence of ground water. In 1900 R. T. Hill discussed the intense folding and faulting of the Paleozoic rocks beneath the relatively flat Cretaceous beds in the Marathon area. Udden (1917) described the Gaptank formation and the Permian rocks in the Glass Mountains. Baker and Bowman (1917) made the first detailed investigation of the structure and stratigraphy of the Marathon basin. The geology of part of the area was described by King (1930) in his report on the geology of the Glass Mountains. His later (1937) report on the geology of the Marathon region has been used freely in the preparation of this report.

Acknowledgments

Appreciation is expressed for the cooperation and assistance of the ranchers and other residents of the Marathon area who granted access to lands and furnished information on wells.

Well-Numbering System

The wells and springs in the Marathon area are numbered according to their location in Brewster County. The county has been divided into 10-minute quadrangles identified by letters, beginning with "A" in the northwest corner of the county and following a west to east, north to south progression. Within the lettered quadrangles, the individual wells are numbered consecutively, beginning in the northwest corner. Thus, well L-1 would be in the northwestern part of quadrangle L.

Physiographic Features

The Marathon area is in the Mexican Highlands physiographic province, in which the land surface consists principally of high plateaus, rugged peaks and sierras, and broad, shallow intermontane valleys. The Marathon area is on a structural uplift, the crest of which has been eroded to a lower level than the flanks, so that the central part is an irregular circular basin surrounded by steep escarpments. The Glass and Del Norte Mountains, which form the north and west margins of the basin, consist chiefly of Permian and Cretaceous rocks that dip gently northward and westward. The inward-facing escarpments are rather steep and have a relief of 1,000 to 1,500 feet. The highest peak in these ranges has an altitude of slightly more than 6,000 feet.

The basin consists of a series of shallow valleys and comparatively flat erosional surfaces separated by northeastward-trending low, sharp ridges. The valley floors in the basin range in altitude from 3,500 feet in the south to 4,500 feet in the north along the base of the Glass Mountains. Local relief within the basin is not great, the summits of the ridges being generally only about 300 to 700 feet higher than the adjacent valleys. The highest peak in the Marathon basin is Horse Mountain (altitude 5,010 feet).

Climate

The Marathon area is semiarid. According to records of the U. S. Weather Bureau, the long-term mean annual precipitation at Marathon is 17.98 inches. Most of the precipitation occurs during the summer, largely in torrential rainstorms of irregular areal distribution. The distribution of precipitation by months is shown in Figure 2.

The mean annual temperature at Marathon is 61.4°F. The observed extremes range from 110° in the summer to below zero in the winter, but ordinarily the seasonal ranges are not so large. The mean monthly temperature at Marathon ranges from less than 46°F in December to more than 75°F in July and August (Figure 2).

Because of the hot summers and low humidity, the evaporation rate at Marathon is high. The nearest long-term evaporation record is for the station at Balmorhea, 60 miles northwest of Marathon. According to records of the Texas Agricultural Extension Service (Bloodgood and others, 1954, page 26; and Bloodgood, 1957, oral communication), the mean annual evaporation from a free-water surface at Balmorhea for the period 1916-55 was 68.22 inches, or nearly four times the mean annual precipitation at Marathon.

Drainage

The greater part of the Marathon area slopes southward and is drained by Maravillas, San Francisco, and smaller creeks, which flow into the Rio Grande. The upper course of Maravillas Creek is apparently subsequent and is cut out along the disturbed zone of the west margin of the Marathon uplift (King, 1937, page 19). Its two northeastern tributaries, Peña Colorada and Dugout Creeks, drain the southern foothills of the Glass Mountains. San Francisco Creek is a consequent stream which has captured the original headwaters of other creeks by headward cutting along belts of weak rock (King, 1937, page 19). Peña Blanca Creek, the main tributary of San Francisco Creek, Woods Hollow, and Hackberry Creeks are subsequent streams that flow in weak-rock belts. The minor tributaries in the trellis drainage pattern flow northeastward or southwestward along belts of nonresistant rocks and, locally, cut southeastward through water gaps in the ridges of resistant rock. The northeastern part of the area is drained by Big Canyon, which flows generally eastward to the Pecos River.

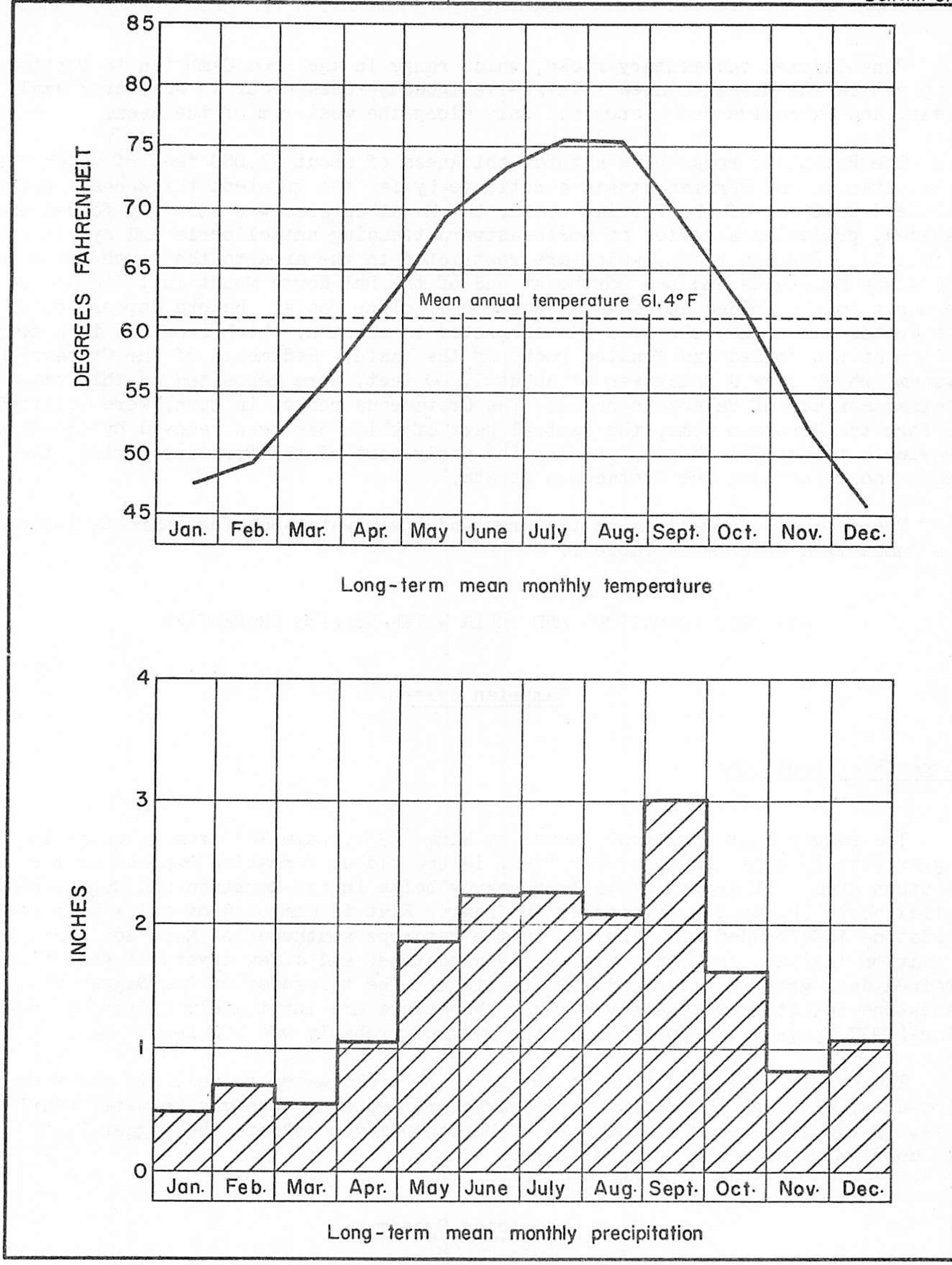


FIGURE 2.— Precipitation and temperature at Marathon

(From records of U. S. Weather Bureau)

GENERAL GEOLOGY

Consolidated sedimentary rocks, which range in age from Cambrian to Tertiary, crop out in the Marathon area. Intrusive igneous rocks occur in scattered small areas, and extrusive rocks crop out only along the west rim of the area.

The Paleozoic rocks have a total thickness of about 21,000 feet of which the Pennsylvanian and Permian strata constitute by far the greatest thickness. Prior to the deposition of the Permian rocks, the Marathon area was strongly folded and faulted, producing a series of northeastward-trending anticlinoria and synclinoria (Plate 1). Permian rocks, which are restricted in the area to the south flank of the Glass Mountains and the northeast end of the Del Norte Mountains, lie unconformably on the folded and faulted surface of older rocks. Before deposition of the Cretaceous rocks, the area was subjected to erosion, which resulted in a truncation of the folded and faulted rocks of the basin. Sediments of the Cretaceous system, which have a thickness of about 1,200 feet, were deposited on this peneplained surface of Paleozoic rocks. The Cretaceous rocks, in turn, were uplifted to form the Marathon dome, the central part of which has been removed by erosion, leaving a topographic basin. During the early part of the Tertiary period, igneous rocks intruded the Cretaceous strata.

The geologic formations in the area and their water-bearing characteristics are summarized briefly in Table 1.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

Cambrian System

Dagger Flat Sandstone

The Dagger Flat sandstone, named by King (1937, page 22) from outcrops in Dagger Flat 13 miles south of Marathon, is the oldest formation exposed in the Marathon area. It crops out in long narrow belts in the Marathon and Dagger Flat anticlinoria (Plate 1). Typically the Dagger Flat is composed of thick beds of sandstone interbedded with shale. In the outcrops southwest of Marathon, the formation includes compact shale, shaly sandstone, and a few layers of very fine-grained dark-gray or black nodular limestone. The thickness of the Dagger Flat sandstone is not known exactly because the strata are intricately contorted, but King (1937, page 22) reported that the maximum probably was 300 feet.

The Dagger Flat sandstone is not known to yield water to wells in the Marathon area, although the medium- and coarse-grained sandstone may be water bearing. A few of the deep wells in the town of Marathon may penetrate the Dagger Flat, but confirming data are not available.

Ordovician System

Ordovician rocks, having a maximum thickness of about 2,100 feet in the Marathon area, crop out in the Marathon and Dagger Flat anticlinoria. The system is represented, in ascending order, by the Marathon limestone and Alsate shale of

Table 1.--Geologic formations of the Marathon area

System and series		Stratigraphic unit	Approximate maximum thickness (feet)	Character of rocks	Water-bearing properties
Quaternary		Alluvium and terrace gravels	125	Clay, silt, sand, and gravel.	Yields small to moderate supplies of water.
Tertiary		Igneous	--	Flows of basalt, trachyte, and andesite; tuff; porphyritic quartz diorite, soda rhyolite, and syenite porphyry.	Not known to yield water in the Marathon area.
Cretaceous			1,000+	Massive cherty limestone, sandstone, shale, and marl.	Not known to yield water in the Marathon area, except for the Edwards limestone, which yields water to springs.
Permian		Capitan limestone	1,800	Massive dolomitic limestone.	Not known to yield water in the Marathon area.
		Word formation	1,500	Siliceous shale, sandstone, conglomerate, and massive limestone.	Yields water to five wells.
		Leonard formation	1,800	Interbedded shale and sandstone, containing thin layers of conglomerate and limestone.	Not known to yield water in the Marathon area.
		Wolfcamp formation	500	Coarse conglomerate, sandstone, shale, and thin beds of fossiliferous limestone.	Yields water to two wells.
Pennsylvanian		Gaptank formation	1,500	Shale, sandstone, limestone, and conglomerate.	Yields small to moderate supplies of water to 10 wells.
		Haymond formation	3,000+	Thin-bedded sandstone and shale; arkose and boulders in upper part.	Not known to yield water.
		Dimple limestone	1,000	Dark-gray limestone, indurated shale, and chert.	Yields small quantities of water to six wells.
		Tesnus formation	6,500+	Interbedded tan or gray-green sandstone and shale.	Yields small quantities of water to 36 wells.
Devonian(?)		Caballos novaculite	600	Novaculite, bedded chert, some shale and limestone.	Yields small quantities of water to springs and seeps.
Ordovician	Upper Ordovician	Maravillas chert	400	Bedded chert, limestone, and conglomerate.	do
	Middle Ordovician	Woods Hollow shale	500	Light-gray-green to tan shale interbedded with sandy limestone and calcareous sandstone.	Not definitely known to yield water to wells.
		Fort Peña formation	200+	Thick-bedded limestone, thin-bedded chert, shale, siltstone, sandstone, and conglomerate.	Yields small quantities of water to wells.
	Lower Ordovician	Alsate shale	145	Thin-bedded limestone, siltstone, chert, indurated greenish shale, sandstone, and conglomerate.	Not known to yield water to wells.
		Marathon limestone	900	Dark-gray flaggy limestone, gray or green clayey shale, conglomerate, and sandstone.	Principal aquifer. Yields water to 92 wells. Yields range from a few to more than 300 gpm.
Cambrian		Dagger Flat sandstone	300	Sandstone interbedded with shale and a few layers of dark-gray or black nodular limestone.	Not known to yield water to wells.

the Lower Ordovician series, the Fort Peña formation and Woods Hollow shale of the Middle Ordovician, and the Maravillas chert of the Upper Ordovician. The Ordovician formations are not differentiated on the geologic map (Plate 1). Only the Marathon limestone is important as a source of ground water in the Marathon area.

Marathon Limestone

The Marathon limestone crops out in the town of Marathon in the Marathon anticlinorium and at the northeast end of the Dagger Flat anticlinorium. The thickness of the Marathon decreases southward, ranging from 800 or 900 feet at Marathon to about 350 feet in the Dagger Flat anticlinorium. The Marathon limestone consists principally of dark-gray flaggy limestone and gray or green clayey shale. Sandstone and conglomerate are interbedded with the limestone and shale. A massive mottled dolomitic limestone near the middle of the formation is 90 feet thick in the Marathon anticlinorium but thins to extinction southeastward.

The Marathon limestone is the most productive aquifer in the Marathon area. It yields water to 92 wells, most of which are in the town of Marathon. The yields of the wells vary widely, ranging from a few gallons per minute to probably more than 300 gpm in well L-106. Most of the water probably is obtained from the limestone beds that have been extensively fractured as a result of folding. Small quantities of water may be obtained from the beds of sandstone and conglomerate and perhaps from the well-indurated, brittle and fractured shale. In the synclinorial belts, the Marathon limestone dips steeply to great depths; consequently, water in these areas is obtained from younger formations at shallower depths. Ground water in the Marathon limestone generally occurs under water-table conditions, but locally it is under artesian pressure and may rise several feet above the point where it is first encountered.

Alsate Shale

The Alsate shale, which crops out in narrow, convoluted belts in the Marathon and Dagger Flat anticlinoria, consists of thin-bedded limestone, indurated greenish shale, lenses of black chert, conglomerate, siltstone, and quartzose sandstone. Shale predominates in the northern exposures of the formation, and limestone in the southern. The Alsate shale ranges in thickness from about 25 feet near Monument Spring (Q-17) to about 145 feet in the Dagger Flat anticlinorium. Drill cuttings from well L-146 indicate a thickness of at least 57 feet for the Alsate shale in the town of Marathon. The upper 25 feet consists of dark-gray brittle, slightly calcareous, partly sandy siltstone and minor amounts of limestone; the lower 32 feet is light- to dark-gray limestone, containing beds of calcareous siltstone (Table 3).

The Alsate shale is not known to yield water to wells in the Marathon area.

Fort Peña Formation

The Fort Peña formation, which unconformably overlies the Alsate shale in the Marathon area, forms low hogbacks roughly parallel to more prominent ridges formed by novaculite of a younger formation. The Fort Peña crops out chiefly along the southeast edge of the Marathon anticlinorium; along the northeastward-plunging axis of the Dagger Flat anticlinorium west of Peña Blanca Spring (S-5); and near Garden Springs (R-26). The Fort Peña consists principally of alternating thick-bedded limestone and thin-bedded chert containing thin partings of shale, and one or more beds of siltstone, sandstone, and coarse conglomerate near the base. The shale beds increase in thickness in the upper part of the formation near the contact with the overlying Woods Hollow shale. The Fort Peña ranges in thickness from about 125 to more than 200 feet; in well L-146 the thickness is 140 feet (Table 3).

The Fort Peña formation probably yields water to four wells: L-149 near Marathon, R-24 and R-29 in the Dagger Flat anticlinorium, and L-146 near Marathon, which draws water from both the Fort Peña and the Marathon limestone. On the basis of the lithology of the formation and the fact that only four wells tap it, only small yields should be expected from the Fort Peña.

Woods Hollow Shale

The Woods Hollow shale is poorly exposed in the Marathon area, cropping out chiefly in gullies and creekbeds between hogbacks formed by the Fort Peña formation and the higher ridges of the overlying Maravillas chert. The Woods Hollow is 300 to 500 feet thick, consisting principally of light gray-green to tan slightly calcareous shale interbedded with laminated sandy limestone and fine-grained calcareous sandstone. The formation is not definitely known to yield water in the Marathon area, although a few wells may obtain small quantities of water from the sandstone or limestone.

Maravillas Chert

The Maravillas chert crops out chiefly on the inner steep slopes of hogbacks formed by the overlying Caballos novaculite. The formation consists of conglomerate, limestone, and chert, the chert predominating toward the top and in the outcrops in the southern part of the area. The Maravillas is 100 to 200 feet thick in the Marathon anticlinorium, but it thickens southward to a maximum of about 400 feet.

The Maravillas chert is not known to yield water to wells in the Marathon area. However, the outcrops are highly jointed and fractured, and water from precipitation that enters the joints and fissures in the weathered chert eventually emerges from springs along contacts with the underlying Woods Hollow shale and overlying Caballos novaculite. The springs provide flow to feed short stretches of several streams in the area. Water in the weathered zones also supports well-defined lines of small bushes and plants on ridge slopes.

Devonian(?) System

Caballos Novaculite

The Caballos novaculite is the principal ridge-forming formation in the Marathon area, making up the ridges or hogbacks that enclose the Marathon and Dagger Flat anticlinoria. Generally the hogbacks are nearly straight, and in places they are broken by water gaps of superimposed streams. The Caballos novaculite consists of five alternating chert and novaculite members. The novaculite, predominant in the southeastern part of the basin, is replaced to some extent toward the northwest by bedded chert containing shale partings and some limestone. The upper novaculite member pinches out halfway across the basin, the lower member extending farther northwestward. The Caballos novaculite ranges in thickness from less than 200 feet in the northwestern part of the Marathon area to about 600 feet in the southern part.

The Caballos novaculite is not known to yield water to wells in the Marathon area, but springs issue from joints or fissures in the weathered parts of the novaculite.

Pennsylvanian System

The Pennsylvanian system of rocks in the Marathon area includes, in ascending order, the Tesnus formation, the Dimple limestone, the Haymond formation, and the Gaptank formation. These rocks, chiefly sandstone and shale and some beds of limestone and conglomerate, reach a maximum thickness of about 12,800 feet. Only the Dimple limestone has been mapped separately; the others are shown as a unit on the geologic map (Plate 1).

Tesnus Formation

The sandstone and shale making up the Tesnus formation form broad valleys between novaculite and limestone ridges in the Marathon area. King (1937, page 56) in a measured section, divided the formation into an upper sandstone member, 4,482 feet thick, and a basal shale member, 2,038 feet thick. On the northwest side of the Dagger Flat anticlinorium, the Tesnus formation, chiefly shale, is not more than 2,000 feet thick. In the northwestern part of the area, where the formation is only about 300 feet thick, black shale predominates; in the southeastern part, where it reaches a thickness of more than 6,500 feet, sandstone predominates. The sandstone is commonly tan or gray-green, friable, and medium- to coarse-grained. A few beds contain arkosic sandstone or quartzite.

The Tesnus formation yields small quantities of water to 36 wells in the Marathon area, most of the water being obtained from beds of sandstone in the upper member. Small quantities of water are obtained in a few places from sandstone layers in the outcrop area of the basal shale member.

Dimple Limestone

The Dimple limestone, which forms low hills and hogbacks ridges in the Marathon area, crops out in narrow sinuous belts and small patches. The Dimple is nearly 1,000 feet thick near Haymond but thins westward to about 100 feet along the flank of the Marathon anticlinorium. The Dimple limestone consists chiefly of dark-gray finely granular limestone containing some dark indurated shale and chert.

The Dimple limestone yields small quantities of water to six wells in the Marathon area.

Haymond Formation

The Haymond formation forms low rolling hills or plains generally mantled by gravel. The formation crops out mainly in the synclinal valleys near Haymond and consists of thin-bedded sandstone and shale, containing thick beds of arkose and boulder-bearing mudstone in the upper part. The Haymond locally exceeds 3,000 feet in thickness.

The Haymond formation is not known to yield water to wells in the Marathon area.

Gaptank Formation

The Gaptank formation crops out in small areas adjacent to the Dugout Creek overthrust west of Marathon (Plate 1). According to King (1937, page 75), the Gaptank is about 1,500 feet thick in the area west of Marathon and consists of shale, sandstone, limestone, and conglomerate.

The formation yields small to moderate supplies of water to 10 stock wells in the Marathon area.

Permian System

The Permian rocks in the Marathon area consist of 5,000 to 7,000 feet of marine sediments cropping out only in the northwestern part, where they form the bulk of the Glass Mountains and part of the Del Norte Mountains. They consist of coarse massive conglomerate, shale, sandstone, massive limestone, thin layers of fossiliferous limestone, and dolomitic limestone. Near the northeast end of the Glass Mountains, limestone predominates; in the northern Del Norte Mountains, sandstone and shale predominate.

King (1937, page 92) divided the Permian section of the Glass Mountains into five formations--the Wolfcamp, Leonard, and Word formations, and the Capitan and Tessey limestones. The Tessey does not crop out in the Marathon area; the other four are shown as a unit in Plate 1. The Permian rocks in the Glass Mountains are tilted toward the north and northwest, the limestone cliffs and escarpments facing south and southeast.

Wolfcamp Formation

The Wolfcamp formation crops out in the southern foothills of the Glass Mountains. In the eastern part of the mountains, the formation conformably overlies the Gaptank formation; in the western part, it rests unconformably on older Paleozoic rocks. In the eastern part of the mountains, the formation consists chiefly of shale and many thin fossiliferous limestone beds; in the western part, it consists of conglomerate, shale, and sandstone. The formation has a maximum thickness of about 500 feet in the Marathon area.

Only two wells, G-1 and G-2, are believed to obtain water from limestone beds of the Wolfcamp formation.

Leonard Formation

The Leonard formation unconformably overlies the Wolfcamp formation and crops out in a belt ranging in width from 2 to 3 miles along the front of the Glass Mountains. The formation has a maximum thickness of about 1,800 feet and makes up a large part of the foothills and escarpments of the Glass Mountains and Dugout Mountain. King (1937, page 98) describes the formation as a clastic series of interbedded shale and sandstone containing thin layers of limestone and conglomerate.

No wells are known to obtain water from the Leonard formation in the Marathon area.

Word Formation

The Word formation forms the intermediate slopes along the southwestern part of the Glass Mountains escarpment and the lower part of the eastward-facing escarpment of the Del Norte Mountains. The formation has a maximum thickness of about 1,500 feet, consisting of siliceous shale, sandstone, conglomerate, and massive limestone.

The formation yields water to five wells in the northern Del Norte Mountains, the water probably occurring in the sandstone or conglomerate.

Capitan Limestone

The Capitan limestone forms prominent bluffs near the crests of the southwest end of the Glass Mountains and the north end of the Del Norte Mountains. The Capitan is about 1,800 feet thick and is composed chiefly of massive dolomitic limestone.

The Capitan limestone is not known to yield water to wells in the Marathon area.

Cretaceous System

The Cretaceous rocks in the Marathon area were deposited on the eroded edges of the folded or tilted Paleozoic rocks, whose surface had been reduced to a peneplain. The Cretaceous rocks dip gently away from the Marathon dome on its north, east, and south sides. On the west side, they are sharply buckled and locally overthrust toward the west. In the Marathon area, remnants of the Cretaceous rocks are exposed only along the upper escarpments and back slopes of the Del Norte Mountains. These rocks, which dip outward from the Marathon uplift, are chiefly massive cherty limestone containing minor amounts of marl, shale, and sandstone. The maximum thickness is about 1,000 feet.

The Cretaceous system is represented mainly by rocks of the Comanche series, including the Trinity, Fredericksburg, and Washita groups, in ascending order. A relatively thin sequence of rocks of the Gulf series is mapped with the rocks of the Comanche series.

The Cretaceous rocks are not important sources of water in the Marathon area, although the Edwards limestone supplies water to two springs (Q-6 and Q-15). Ground water moves downward through joints, fissures, and solution channels in the massive Edwards limestone and issues through springs at the contact of the Edwards and the underlying less permeable Comanche Peak limestone and Walnut clay.

Tertiary System

The Tertiary system in the Marathon area is represented by igneous rocks of both volcanic and intrusive types. The volcanic rocks of early Tertiary age are chiefly tuffs and flows of basalt, trachyte, and andesite. They crop out only in the Del Norte Mountains, where they overlie Cretaceous rocks (Plate 1).

The intrusive rocks, which are younger than the volcanic rocks, crop out in widely scattered small areas and consist mainly of syenite porphyry, rhyolite, and quartz-diorite porphyry. The intrusive rocks occur as dikes, plugs, and laccoliths that have invaded all the sedimentary rocks, from the oldest to the youngest (King, 1937, page 117).

The igneous rocks are not known to yield water to wells in the Marathon area.

Quaternary System

Quaternary sediments mantling the present stream valleys and the eroded rock floors of the Marathon area were differentiated by King (1937, page 116) into older gravel deposits and more recent alluvium. The gravel deposits, which form alluvial fans along the mountain fronts and terraces in the adjacent lowlands, consist of pebbles and cobbles of limestone, chert, and novaculite in a matrix of clay and fine fragmental material. The gravel is not more than 30 feet thick except along the base of the escarpment of the Glass Mountains, where it may be as much as 125 feet thick. The alluvium, chiefly in the valleys of Maravillas and Dugout Creeks and smaller tributary streams, consists of clay, silt, sand, and larger detritus and generally is less than 30 feet thick.

More than 50 wells shown on Plate 1 are in outcrops of Quaternary rocks. However, only a few shallow wells near creekbeds obtain water from the gravel or alluvial deposits, most of the wells being drilled to the underlying Paleozoic rocks, which furnish a more dependable supply of water. The Quaternary sediments serve as a catchment area for rainfall and, therefore, aid in the recharge of the underlying rocks.

GROUND WATER

Occurrence and Movement

The occurrence, availability, and movement of ground water in the Marathon area are controlled, in large part, by the geologic structure. The Marathon limestone, the principal aquifer in the area, is found chiefly in the Marathon and Dagger Flat anticlinoria, where upfolding has brought the formation to relatively shallow depths. In these areas, the water occurs under water-table conditions in crevices, joints, and cavities in the limestone. In other words, the water is unconfined and will not rise in wells above the level at which it is found in the formation. In the synclinorial belts, the Marathon limestone is downfolded and occurs at great depths; therefore, in these belts wells generally tap shallower aquifers of Pennsylvanian age. Where the Marathon limestone is buried beneath younger formations, the water is under artesian pressure--that is, it is confined between relatively impermeable strata and will rise in wells above the level at which it is encountered.

Ground water moves by gravity through openings in the rocks from intake or recharge areas toward lower levels and ultimately to points of natural discharge. In general, ground water moves down the dip of the beds because the permeability is greatest parallel to the bedding. However, the movement may be retarded or the direction changed because of a decrease in permeability as a result of the intense folding and faulting in the Marathon area. Water thus may move laterally across the strata and into adjacent beds. In many places this lateral movement is impeded by impermeable barriers, such as the Caballos novaculite. On encountering such a barrier, a part of the water may move downdip below the barrier, but most of the water moves at near-surface levels around, or through a gap in, the barrier.

In general, the ground water in the Marathon area moves southward and southeastward toward the Rio Grande. Although data are not available to map the water table accurately, meager information in the immediate vicinity of Marathon indicates that the pumping of about 100 wells in the city has created a trough in the water table and that the ground water moves toward the trough, thence southwestward toward Peña Colorada Spring, where it is discharged as springflow.

Ground water is at relatively shallow depths in most of the Marathon area. (See Plate 2.) The depth of most wells is less than 250 feet, wells drilled to greater depths being mainly in or near the Del Norte and Glass Mountains. The depth to water in 205 wells in the area is less than 150 feet below the land surface, and in 72 wells it is less than 50 feet.

Recharge

Ground-water reservoirs in the Marathon area are recharged principally by infiltration of precipitation and stream runoff and to a much smaller extent by underground inflow from outside the area.

The amount of precipitation that reaches the water table is determined by the duration, intensity, and type of precipitation, the thickness of the vegetative cover, the porosity and permeability of the soil and underlying rocks, and the areal extent of the recharge area. A large part of the precipitation occurs during the summer, when the evaporation rate is high; thus, only a small fraction of the precipitation escapes evaporation and becomes recharge. Most of the recharge occurs from the torrential rains that fall during the summer. Runoff from these downpours emerges from the steep slopes of the mountainous areas, spreads out over the alluvial fans, and percolates into the coarse material forming the fans. If precipitation at Marathon is considered to be representative of the area, the annual precipitation of nearly 18 inches is equal to about 730,000 acre-feet of water per year. Under similar conditions, Littleton and Audsley (1957, page 26) estimated that less than 5 percent of the annual rainfall in the neighboring Alpine area reaches the ground-water reservoir. On this basis, probably somewhat less than 35,000 acre-feet annually reaches the water table in the

Marathon area. This figure may be excessive because of the difficulty in determining accurately the area of effective recharge.

Recharge by underground flow into the area probably is negligible. Conditions for inflow from the north and west are not favorable because the rocks on those sides dip away from the area. Along the southern boundary, underflow is outward from the area. From the east, some underflow may enter the area, moving southwestward along San Francisco Creek.

Discharge

Ground water is discharged to the land surface in the Marathon area naturally by springs and evapotranspiration and artificially by wells. Ground water is discharged from the area in the subsurface as underflow southward toward the Rio Grande. The amounts of discharge by evapotranspiration and underflow have not been determined; however, estimates of the discharge by springs and wells can be made.

Natural Discharge

The combined yield of 11 springs in the Marathon area in 1957 was estimated to be about 420 gpm, or about 660 acre-feet per year. Peña Colorada Spring (R-4), the largest, had an average flow of about 300 gpm, the water issuing from Quaternary and Ordovician rocks. The rest had flows ranging from $\frac{1}{2}$ to 40 gpm. Springs Q-6 and Q-15 discharge water from the Edwards limestone near its contact with the underlying Comanche Peak limestone and Walnut clay. In the outcrops of the Caballos novaculite and associated cherts, water moves at shallow depths through joints and fractures, emerging as springflow at the contact of the novaculite and the overlying shale of the Tesnus formation through such springs as Sunshine Springs (R-7) and Reed Spring (S-16). At Simpson Springs (R-20), the water issues from several minutely fractured zones in the novaculite and chert, where a small valley has been cut through an anticlinal axis in the Caballos novaculite.

Monument Spring (Q-17), Rock House Spring (Q-19), and Peña Blanca Spring (S-5) are along the southeast limb of either the Marathon or the Dagger Flat anticlinoria, where gaps have been cut through ridges of steeply dipping Caballos novaculite (Plate 1). Ground water, moving from the northwest through relatively thin alluvium and underlying Ordovician rocks, is ponded behind barriers formed by the Caballos novaculite and overflows through the gaps. The first flow or seep appears upstream from the outcrop of the Maravillas chert, emerging from a thin mantle of alluvium or gravel overlying the chert. Water flows on the surface southeastward through the gap in the Caballos novaculite, disappearing again into Quaternary alluvium or sandstone of the Tesnus formation on the downstream side of the gap.

Water emerges from the alluvium at several points along Maravillas Creek, where the creek crosses outcrops or near-surface ridges of Caballos novaculite or other impermeable rocks. Similarly, shallow subsurface flow comes to the surface where San Francisco Creek crosses relatively impermeable strata in the Pennsylvanian rocks, particularly the lower shales in the Tesnus formation several miles south of Haymond.

An undetermined, but probably large, part of the ground water moves out of the Marathon area as underflow through the alluvium and permeable Paleozoic rocks along the valleys of Maravillas, Woods Hollow, Hackberry, and San Francisco Creeks and minor drainageways. The water flows across the southern boundary of the Marathon area toward the Rio Grande.

A large quantity of ground water probably is discharged in the Marathon area through evapotranspiration. The amount of water discharged varies with the season, being greatest during the summer when temperatures are highest. Discharge by direct evaporation occurs at several places along Peña Colorada Creek, Maravillas Creek, and other streams, where the water table is at or near the land surface.

Artificial Discharge

Ground water was artificially discharged through about 280 wells in the Marathon area in 1957. The total withdrawal probably was less than 400,000 gpd (gallons per day), or 450 acre-feet per year. This is less than 2 percent of the estimated natural recharge. More than half the wells in the area are used for watering stock. The wells are equipped with windmills and generally yield less than 10 gpm. A few of the domestic wells yield as much as 25 gpm, although most of them are pumped at rates of less than 10 gpm. Several wells used for railroad, public supply, or irrigation had reported yields of 40 to 210 gpm.

Fluctuations of Water Levels

Water levels in wells in the Marathon area fluctuate chiefly in response to changes in rates of recharge and discharge. Other forces that affect the water levels but are probably insignificant in the Marathon area include atmospheric pressure, earthquakes, earth tides, and surface loading.

The fluctuations of water levels in four wells in the Marathon area (L-106, R-3, M-7, and M-26) for the period September 1956 to November 1957 are shown in Figure 3. The hydrographs show very little net change in water level during this period, indicating no significant change in the amount of water in storage.

The fluctuations in water levels in wells L-106 and R-3 are similar. Well L-106, in Marathon, taps the Marathon limestone and well R-3, about $3\frac{1}{2}$ miles southwest of well L-106, taps the alluvium, which is hydraulically connected with the Marathon limestone in the area between the two wells. The fluctuations of water levels in wells M-7 and M-26, 7 miles northeast and 6 miles east of Marathon, are similar to each other, but they are unlike those of wells L-106 and R-3. Wells M-7 and M-26 are separated hydraulically from the other two by the relatively impermeable Woods Hollow shale-Maravillas chert-Caballos novaculite sequence, which forms a barrier to ground-water movement. The different patterns of water-level fluctuations of the two pairs of wells indicate that changes in storage of ground water on opposite sides of the barrier are dependent upon different areas and conditions of recharge and discharge.

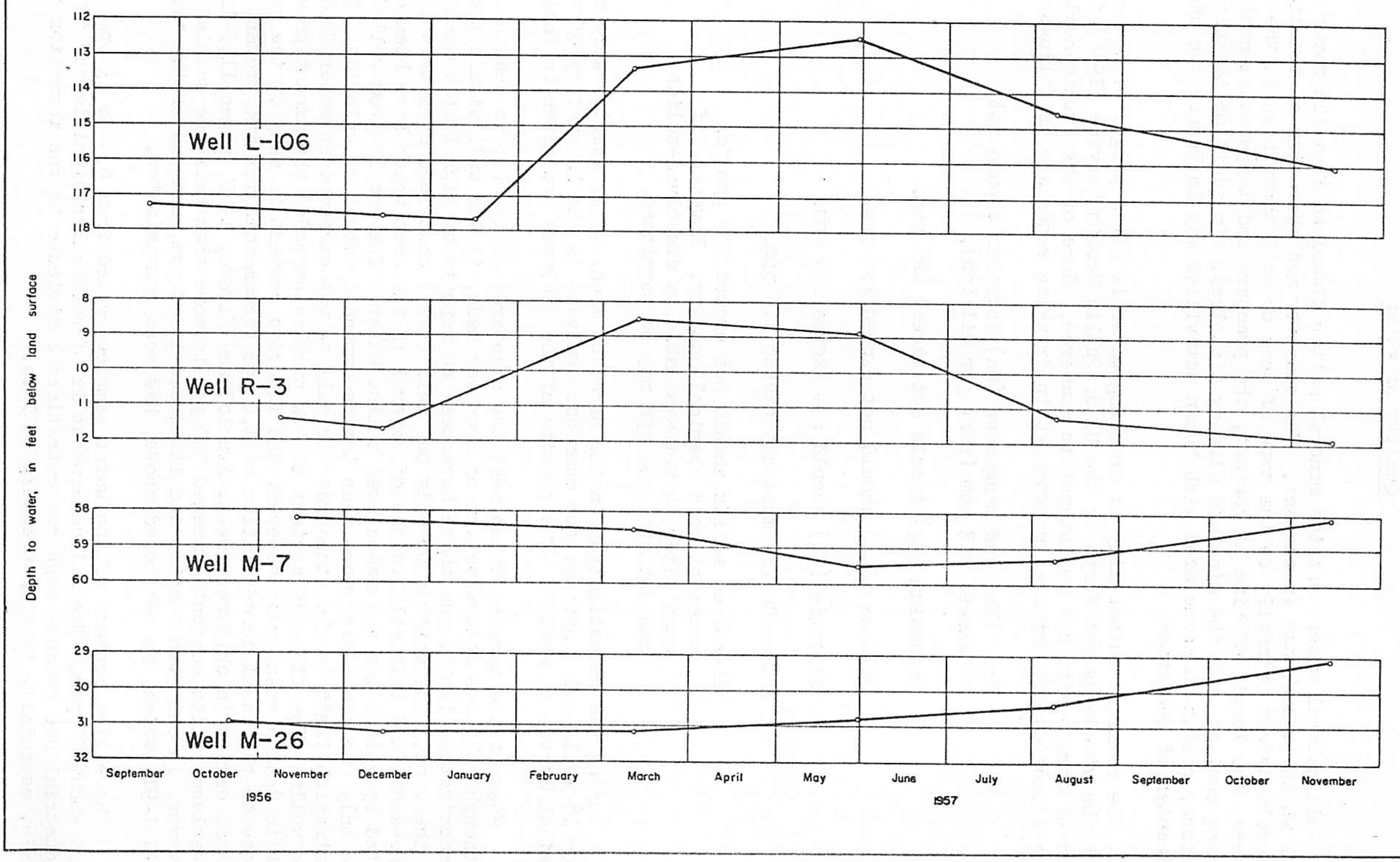


FIGURE 3.-Fluctuations of water levels in selected wells in the Marathon area, 1956-57

Quality of Water

All natural water contains mineral matter dissolved from the rocks and soils with which it has come in contact. The quantity and character of the dissolved minerals depend primarily on the type of rock or soil through which the water has passed, the length of time of contact, the pressure and temperature conditions during contact, and the minerals already dissolved. In addition to these natural factors, pollution associated with human activities may influence the chemical character of the water.

The chemical suitability of drinking water is often judged by comparing it with the standards set forth by the U. S. Public Health Service (1946) for water used by common carriers in interstate commerce. Some of the Public Health Service standards for chemical substances in drinking water are as follows:

Iron (Fe) and manganese (Mn) together should not exceed 0.3 ppm (part per million).

Magnesium (Mg) should not exceed 125 ppm.

Sulfate (SO_4) should not exceed 250 ppm.

Chloride (Cl) should not exceed 250 ppm.

Fluoride (F) must not exceed 1.5 ppm.

Dissolved solids should not exceed 500 ppm for water of good chemical quality. However, if such water is not available, a dissolved-solids content of 1,000 ppm may be permitted.

During the investigation in the Marathon area, water samples were collected from 18 wells and 3 springs for chemical analysis in the laboratory of the Geological Survey in Austin. The results of the analyses are given in Table 4.

Most of the samples taken meet the standards of the Public Health Service. Although only one determination of iron was made, it was well within the accepted concentration limit, and there have been no reports of high iron content in water in the area. The water from only one well (L-91) contained more than 125 ppm of magnesium, and this well is one of several in the area which have been contaminated by oil or gas and associated saline water. The sample from well L-91 was the only one containing more than the recommended amount of chloride. The concentration limit in the standards for sulfate was exceeded in water from only two wells. The fluoride content of six samples exceeded the amount permitted by Public Health standards; however, the fluoride content in many of the samples was close to the ideal concentration of 1.0 ppm recommended for the prevention of dental caries in children (Dean, Arnold, and Elvove, 1942, pages 1155-1179). The dissolved-solids content exceeded 500 ppm in more than half the samples collected; however, in only two samples did it exceed 1,000 ppm, and one of the two was from well L-91, which, as mentioned above, has been contaminated.

The silica content of the water samples ranged from 6.4 to 43 ppm and averaged about 20 ppm. The silica content is of particular significance in water for industrial use because high concentrations contribute to the formation of boiler scale, especially in high-pressure boilers.

The nitrate content ranged from 0 to 19 ppm, but in most of the samples the concentration was less than 5 ppm. High nitrate content may be an indication of pollution from organic sources, such as sewage, and wells having excessive nitrate content should be tested for bacterial contamination.

The hardness of the water in all but two of the samples ranged from 85 to 434 ppm. The water from the contaminated well (L-91) had a hardness of 1,420 ppm, and the water from well L-152 had a hardness of 844 ppm. All the samples would be rated as hard, the upper limit of soft water generally being considered to be about 60 ppm. Hardness of as much as 150 ppm would not seriously interfere with the use of water for most purposes other than by causing a slightly increased consumption of soap. When hardness is in excess of 200 ppm, as it was in most of the samples taken in the Marathon area, it is common practice to soften the water for household use.

Most of the ground water in the Marathon area is suitable for irrigation, the analyses comparing favorably with the criteria proposed by the U. S. Salinity Laboratory Staff (1954) for the classification of irrigation waters; however, no determinations of boron content were made. These criteria for quality of irrigation waters are based upon the content of dissolved solids, the relative proportion of sodium to the other cations, the concentration of boron and other toxic elements, and, sometimes, the bicarbonate concentration in relation to the sum of the calcium and magnesium concentrations.

Owners of nine of the wells listed in Table 2 have reported that the water is contaminated by oil, gas, and saline water. In addition to these, 10 other wells in the vicinity are reported to yield water of poor quality, probably similar to that of well L-91, one of the contaminated wells. All but three of the wells are in the northwestern part of the town of Marathon; the others are in the vicinity of well L-112, just south of the center of town. At a few places, the contamination is sufficient to render the water unsuitable for practically all uses. As early as 1937, King (1937, page 143) noted that some of the wells were contaminated by oil "...that does not appear to have come from storage tanks or other surface supplies. These oil showings suggest that the Gaptank formation in this district contains oil. The wells near Marathon, where the country rock is of Ordovician age, may receive their oil from the Gaptank formation by migration upward through the plane of the Dugout Creek overthrust." Although the source of contamination has not been confirmed, the contamination appears to be spreading slowly eastward. Some well owners in the northern part of Marathon report that water from their wells is of poorer quality than it was in 1952. The oil and gas are apparently encountered near the top of the zone of saturation, so that most of the contamination is at depths of about 90 to 140 feet. In one well (L-61) the contaminated zone has been successfully cased off, and water of suitable quality is obtained from greater depth.

CONCLUSIONS

The Marathon limestone and the alluvial deposits are the major aquifers in the Marathon area, yielding small to large quantities of water in the Marathon and Dagger Flat anticlinoria. Minor aquifers, chiefly sandstone of Pennsylvanian age, yield smaller quantities of water. The complex folding and faulting in the Marathon area control to a large extent the occurrence and availability of ground water. The Marathon limestone is most widely used in the anticlinorial belts, where it has been upfolded and occurs at shallow depths. In the synclinorial areas, the Marathon has been downfolded and occurs at great depths; consequently, the overlying Pennsylvanian rocks, which yield smaller quantities of water, are the principal aquifers in those areas.

Yields of wells in the Marathon area range from only a few gallons to as much as 300 gpm. Most of the wells are used for domestic and stock purposes and are constructed so as to produce only small quantities of water. Larger yields could be obtained from properly constructed wells in many places, especially where the Marathon limestone occurs at shallow depth or where the alluvial deposits are thick.

The aquifers underlying the Marathon area are recharged principally by precipitation on the area. The immediate source of most of the recharge probably is runoff from the mountainous areas after torrential rainstorms. The annual recharge is estimated to be on the order of 35,000 acre-feet per year. Ground water is discharged mainly by underground flow out of the area toward the south and to a lesser extent by springflow, pumpage from wells, and evapotranspiration. The average discharge through wells is about 400,000 gpd, or 450 acre-feet per year; the spring discharge is about 420 gpm or about 660 acre-feet per year. The amounts of discharge by underground flow and evapotranspiration are not known.

Most of the ground water in the Marathon area is of suitable chemical quality for public and domestic supply except that it is very hard. Concentrations of fluoride may exceed the recommended limit in a third to a fourth of the supplies. Contamination of the ground water by oil and gas and accompanying saline water has been noted in the vicinity of Marathon, and in a few wells the contamination has been sufficient to render the water unsuitable for most purposes.

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Table 2.--Records of wells and springs in the Marathon area, Brewster County

All wells are drilled unless otherwise noted in Remarks column.
Water level : Reported water levels given in feet; measured water levels given in feet and tenths.
Method of lift and type of power: C, cylinder; E, Electric; G, gasoline, butane or Diesel engine; N, none; T, turbine; W, windmill. Number indicates horsepower.
Use of water : D, domestic; Irr, irrigation; N, none; P, public supply; RR, railroad; S, stock.

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level		Method of lift	Use of water	Remarks
							Below land surface datum (ft.)	Date of measurement			
F-1	Leonard Hess	--	1928	710	--	--	580	1956	C,W	S	Original depth 610 ft.; deepened to 710 ft. in 1929. Jug Tank well.
F-2	do	--	1928	250	6	--	171.8	Oct. 3, 1956	C,W	D,S	
F-3	do	G. W. Hargus	1931	250	6	--	184.6	do	N	N	
F-4	do	-- Clark	1938	250	8	--	171.6	do	C,E	D,S	
F-5	do	-- Seal	1940	270	8	--	162.4	do	C,W	S	
G-1	Bill Neal	--	--	300	10	Wolfcamp(?) formation	--	--	C,G	S	
G-2	do	--	1944	300	8	do	--	--	C,W	S	
G-3	Leonard Hess	-- Clark	1935	90	8	Quaternary(?) rocks	69.9	Oct. 2, 1956	C,W	S	
G-4	Bill Neal	--	--	250	5	--	--	--	C,W	S	
G-5	Mrs. Wayne Moore	G. W. Hargus	--	160	--	--	--	--	C,W	S	
G-6	do	do	--	160	--	--	--	--	C,W	S	
G-7	--	--	--	--	--	--	--	--	C,W	S	
G-8	Combs-Kincaid Ranch	--	--	125	6	--	92.5	Nov. 15, 1956	C,W	S	Adams well. Old well.
*G-9	do	G. W. Hargus	1955	100	6	Dimple limestone	72.2	Mar. 11, 1957	C,W	S	Temp. 67°F.
G-10	do	do	1953	125	6	Quaternary(?) rocks	17.4	Nov. 16, 1956	C,W	S	Hancock well.
G-11	do	do	1951	125	6	--	41.7	Nov. 15, 1956	C,W	S	Orchard well.
K-1	Catto-Gage Ranch	do	1944	650	6	Word(?) formation	600	1957	C,W,E	S	Strong supply reported. Water is piped to Altuda. Lemmons well.
K-2	do	do	1939	550	6	do	515	1957	C,E	S	Reported saline water. Square Tank well.
K-3	Decie Bros.	do	1946	900	--	--	810	1956	C,W	S	

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
K-4	Catto-Gage Ranch	G. W. Hargus	1949	500	6	Word(?) formation	470	1957	C,E	D,S	Supplies one house and several stock tanks by pipelines. West Place well.
K-5	do	do	1953	400	--	do	384	1957	C,W	S	
K-6	do	do	1951	280	6	do	270.8	Aug. 21, 1957	C,W	S	Strong supply reported. Red Tank well.
K-7	Decie Bros.	do	--	125	--	Gaptank formation	63.7	Nov. 14, 1956	C,W	S	
K-8	do	--	--	--	--	--	--	--	N	N	Oil-test well.
K-9	do	-- Smith	1936	1,100	9	--	253.4	Nov. 7, 1956	C,W	S	Reported gas odor.
K-10	Catto-Gage Ranch	--	--	--	--	--	--	--	N	N	Oil-test well. Wilcox & Anderson-Gage well 1. Plugged and abandoned.
K-11	do	G. W. Hargus	--	130	6	Gaptank formation	86.9	Aug. 22, 1957	C,W	S	Red Mill well. Old well.
K-12	do	do	1942	150	6	do	87.6	do	C,W	S	Billy-Trap well.
K-13	Combs Post Ranch	--	--	650	6	--	--	--	C,W	S	Lenox well. Old well.
K-14	Catto-Gage Ranch	-- Clark	1935	500	6	--	100	1957	C,W	S	Dugout well.
K-15	do	--	--	225	6	--	200	1957	C,E	D,S	Arnold well.
K-16	do	Emmett Meeks	1920	150	6	--	127.9	Aug. 22, 1957	C,W	S	Negley Trap well.
L-1	West-Pyle Cattle Co.	--	--	--	7	Gaptank(?) formation	84.7	Oct. 14, 1957	C,W	S	Reported weak supply.
L-2	Decie Bros.	G. W. Hargus	--	200	--	--	--	--	N	N	
L-3	do	--	1939	180	6	--	--	--	C,W,G	S	Casing: 6-in. to 140 ft.
L-4	do	G. W. Hargus	1948	140	6	--	78.3	Nov. 9, 1956	N	N	
L-5	do	do	1950	250	6	--	--	--	C,W	S	
L-6	do	do	1950	400	--	--	--	--	N	N	
L-7	do	--	--	365	--	--	--	--	N	N	
L-8	West-Pyle Cattle Co.	--	--	--	6	--	--	--	C,W	S	
L-9	do	--	--	--	--	--	--	--	C,W	S	

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
L-10	West-Pyle Cattle Co.	--	--	--	7	Dimple(?) limestone	34.0	Oct. 7, 1957	C,W	S	
L-11	do	--	--	--	--	--	--	--	C,W	S	
L-12	do	--	--	--	6	Quaternary(?) rocks	37.3	Oct. 16, 1957	C,W	D,S	
L-13	Leonard Hess	--	1900	200	6	--	162.4	Oct. 2, 1956	C,W	S	Dug to 90 ft.; drilled to 200 ft. Red Mill well.
L-14	do	--	1900	150	8	--	108.5	Oct. 3, 1956	C,W	D,S	Reported strong supply. Willow well.
L-15	West-Pyle Cattle Co.	--	--	--	6	--	132.7	June 7, 1956	N	N	
L-16	do	--	--	--	6	--	141.0	do	C,W	S	
L-17	do	--	--	--	7	--	--	--	C,W	S	
L-18	do	--	--	--	10	--	63.0	Oct. 17, 1957	C,W	S	
L-19	Leonard Hess	-- Seal	1940	150	6	--	85.2	Oct. 2, 1956	C,W	S	Reported strong supply. Upper Stockton well.
L-20	do	--	--	150	8	--	59.8	do	C,W	S	Reported strong supply. Lower Stockton well. Old well.
L-21	West-Pyle Cattle Co.	--	--	--	6	--	--	--	C,W	S	
L-22	do	--	--	--	8	--	44.2	Oct. 16, 1957	C,W	S	
L-23	Decie Bros.	-- Dewey	--	260	--	--	--	--	N	N	Oil-test well. Plugged and abandoned.
L-24	do	--	--	1,200	--	--	--	--	N	N	Oil-test well. Ava Scribner-Wedin No. 1. Plugged and abandoned.
L-25	do	--	--	440	--	Gaptank formation	67.2	Nov. 9, 1956	C,W	S	Old well.
*L-26	do	G. W. Hargus	1946	120	7	do	50.6	Nov. 7, 1956	C,W	S	Temp. 66°F.
L-27	do	--	--	150	6	do	52.0	Nov. 9, 1956	C,W	D,S	Old well.
L-28	do	--	--	150	5	Gaptank(?) formation	--	--	C,W	S	Reported strong supply. Old well.
L-29	West-Pyle Cattle Co.	--	--	--	9	--	--	--	C,W	S	

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
L-30	West-Pyle Cattle Co.	--	--	--	6	--	--	--	C,W	S	
*L-31	Decie Bros.	G. W. Hargus	1940	250	8	--	92.4 92.9	Nov. 7, 1956 Dec. 13, 1956	C,W	S	Altitude of land surface 4,080.9 ft. Temp. 68°F.
L-32	do	--	--	150	6	--	--	--	C,W	S	Old well.
L-33	do	--	--	100	6	Gaptank formation	58.1 60.7	Nov. 7, 1956 Dec. 13, 1956	C,W	S	Altitude of land surface 4,114.3 ft.
L-34	Combs Post Ranch	--	--	100	6	Quaternary(?) rocks	43.4	Nov. 9, 1956	C,W	S	North Hargus well. Altitude of land surface 4,114.1 ft.
L-35	--	--	1921	3,665	--	--	--	--	N	N	Oil-test well. Alexander Syndicate-Hargus No. 1. 1/
*L-36	Combs Post Ranch	--	--	100?	6	Gaptank formation	--	--	C,W	S	South Hargus well. Temp. 74°F. Old well.
L-37	do	G. W. Hargus	--	100	6	Marathon limestone	48.3	Nov. 7, 1956	C,W	S	Paint well.
L-38	do	--	--	150	6	Marathon(?) limestone	42.4 43.0	Nov. 7, 1956 Dec. 13, 1956	C,W	S	Altitude of land surface 4,016.2 ft. Spruce well. Old well.
L-39	U. J. Adams	Homer Spruce	1926	30	--	Quaternary rocks	23	1956	C,W	D,S	Dug. Reported strong supply.
L-40	Combs Post Ranch	--	--	85	6	Marathon limestone	58.8 59.3	Nov. 6, 1956 Dec. 13, 1956	C,W	S	Crawford well. Old well.
L-41	West-Pyle Cattle Co.	--	--	--	7	--	182.1	Oct. 17, 1957	C,W	S	
L-42	do	--	--	--	7	--	--	--	C,W	S	
L-43	Forker-Gage Ranch	--	--	125	6	--	14.6 17.2	Oct. 4, 1956 Dec. 13, 1956	C,W	S	Beckley well.
L-44	Francis Springfield	G. W. Hargus	1946	350	--	Marathon(?) limestone	145.3	Nov. 14, 1956	C,E	D	
L-45	Brewster County	--	--	280	7	Marathon limestone	149.1	Oct. 23, 1956	C,E, 2	D	Original depth 208 ft.; deepened to 280 ft. in 1957. Reported strong supply of water at 275 ft. Old well.
L-46	Clinton Ritchey	A. Burnham	1905	--	7	Marathon(?) limestone	152.5	Sept.27, 1956	C,W	D	

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
L-47	Tom Yarbro	A. Burnham	1905	250	--	Marathon limestone	151.9 152.9	Aug. 6, 1956 Dec. 13, 1956	C,W	D	Altitude of land surface 4,110.1 ft.
L-48	W. G. Gulihur	--	--	225	--	do	--	--	C,E	D	Supplies water for 5 homes. Old well.
L-49	David Combs	A. Burnham	--	--	5	Marathon(?) limestone	154.7	Nov. 1, 1956	C,W	D	
L-50	E. H. Todd	G. W. Hargus	1916	310	--	do	--	--	C,E	D	Original depth 160 ft.; deepened to 310 ft. in 1947.
L-51	Frank Wedin	do	--	204	--	Marathon limestone	--	--	C,W	D	Supplies water for 7 families.
*L-52	J. N. Allebrand	A. Burnham	1925	200	6	do	139.0 141.6	Sept.27, 1956 Dec. 13, 1956	C,W	D	Altitude of land surface 4,095.7 ft. Supplies water for hotel. Temp. 68°F.
L-53	Earl Meeks	--	--	--	--	Marathon(?) limestone	--	--	C,E, 1	D	
L-54	E. B. Hancock	A. Burnham	1905	200	--	Marathon limestone	141.8 141.3	Aug. 3, 1956 Dec. 11, 1956	C,W	D	Altitude of land surface 4,098.6 ft.
L-55	W. E. Young	G. W. Hargus	1950	167	12	do	141.5	Nov. 2, 1956	C,W	D	
L-56	W. E. Rau	--	--	--	6	Marathon(?) limestone	147.7 143.2	Sept.27, 1956 Dec. 13, 1956	C,W	D	Altitude of land surface 4,100.5 ft.
L-57	L. C. Ritchey	G. W. Hargus	1939	215	6	Marathon limestone	140	1956	C,E	D	
L-58	C. A. Maddox	do	1955	195	--	do	151.5	Sept.25, 1956	C,E	D	
L-59	Don Parker	--	--	--	9	Marathon(?) limestone	--	--	C,E, 3/4	D	
L-60	Marathon Independent School District	G. W. Hargus	--	--	8	do	--	--	C,E, 1½	D	
L-61	Bud Kimbel	--	1912	282	--	Marathon limestone	--	--	C,W	D	Original depth 180 ft.; deepened to 282 ft. in 1948. Reported oil contamination at 140 ft.
L-62	Marathon Independent School District	G. W. Hargus	1948	300	--	do	--	--	C,E	P	Discharge reported 20 gpm in 1956. Supplies water for school.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level		Method of lift	Use of water	Remarks
							Below land surface datum (ft.)	Date of measurement			
L-63	Marshall Roberts	G. W. Hargus	1946	178	--	Marathon limestone	144.9	Sept.25, 1956	C,E, 1	D	
L-64	Steve Stumberg, Jr.	do	1946	225	--	do	--	--	C,E, 1	D	
L-65	J. J. Roberts	do	1944	223	6	do	144.7 144.8	Sept.25, 1956 Dec. 13, 1956	C,W	D	Altitude of land surface 4,101.8 ft.
L-66	-- Miller	--	--	--	10	Marathon(?) limestone	--	--	C,W	D	
L-67	Mrs. W. F. Crawford	Otto Lochausen	1925	140	9	Marathon limestone	123.9	Oct. 1, 1956	C,E, 1½	D	Altitude of land surface 4,081.3 ft.
L-68	G. W. Hargus	--	1926	--	--	Marathon(?) limestone	--	--	C,E	D	
L-69	W. W. Hargus	G. W. Hargus	1949	160	6	Marathon limestone	130.3	Sept.27, 1956	C,E 3/4	D	
L-70	Lloyd Wade	--	--	300	6	do	--	--	C,E	D	
L-71	W. J. Shackleford	G. W. Hargus	1940	170	--	do	--	--	C,E, 1	D	
L-72	J. J. Roberts	do	1941	206	6	do	145.6	Sept.25, 1956	C,W	D	
L-73	A. W. Haley	--	--	200	--	do	125.4	Nov. 1, 1956	C,E, 1	D	Altitude of land surface 4,082.5 ft.
L-74	Mrs. R. W. Arnold & Mrs. J. W. Worthington	--	1926	150	--	do	132.0	Sept.24, 1956	C,W	D	
L-75	Lee Dickson	-- Stewart	1909	174	6	do	--	--	C,W	D	Reported saline water.
L-76	Mrs. J. J. Miller	--	--	150	6	do	137.5	Oct. 1, 1956	C,W	D	
L-77	John I. Smith	G. W. Hargus	1952	180	8	do	132.5 128.7	Oct. 1, 1956 Dec. 12, 1956	C,E, 1	D	Altitude of land surface 4,085.7 ft.
L-78	J. R. Smith	--	--	300	6	do	--	--	C,W	D	
L-79	L. A. Preston	G. W. Hargus	1942	185	--	do	--	--	C,W	D	

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
L-80	Jessie H. Hollis	--	--	130	--	Marathon limestone	77.6	Nov. 9, 1956	C,W	D	Old well.
L-81	Nanny Crawford	--	--	140	--	do	--	--	C,W	D	do
L-82	Charles Smith	G. W. Hargus	1956	139	5	--	87.4	Aug. 3, 1956	N	N	Casing: 5-in. to 110 ft. Oil contamination reported at 110 ft.
L-83	West Texas Utilities Co.	do	1927	276	--	--	--	--	N	N	Reported saline water.
L-84	Frank Wedin	Frank Wedin	--	97	7	--	--	--	N	N	Oil contamination reported.
L-85	Gage Estate	Andrew Kendrick	1920	--	6	--	--	--	N	N	
L-86	O. M. Roberts	do	1920	165	--	Marathon limestone	111.4	Nov. 1, 1956	C,W	D	Reported gas contamination.
L-87	Travis Roberts	W. J. Shackleford	--	170	6	do	112.7	Oct. 1, 1956	C,W	D	Altitude of land surface 4,069.8 ft.
L-88	W. M. Green	--	--	200	--	do	118.1	do	C,W	D	
L-89	--	--	--	--	5	--	108.4 108.7	Nov. 1, 1956 Jan. 14, 1957	N	N	Altitude of land surface 4,065.4 ft.
L-90	C. A. Haynes	--	--	320	--	Marathon(?) limestone	--	--	C,E, 2	D	
*L-91	John M. Mess	G. W. Hargus	--	165	--	Marathon limestone	100.0 101.4	Aug. 6, 1956 Dec. 13, 1956	C,W	D	Oil contamination reported at shallow depth. Altitude of land surface 4,061.5 ft. Temp. 68°F.
L-92	Tom Henderson	-- Haney	1898	275	6	--	--	--	C,E, 2	N	Oil contamination reported.
L-93	Sam Nail	--	--	--	6	Marathon(?) limestone	--	--	C,W	D	
L-94	F. P. Rooney	G. W. Hargus	--	300	7	Marathon limestone	--	--	C,W	D	
L-95	J. A. McGonagil	do	1946	273	--	do	113.3	Sept.25, 1956	C,W	D	
L-96	F. D. Dorward	Bill Gulihur	1936	192	--	--	93.0	Sept.26, 1956	N	N	Oil contamination reported.
L-97	Gulf Oil Corp.	G. W. Hargus	1948	200	--	--	110	1956	N	N	Gas contamination reported.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
L-98	Biddy Martin, Jr.	--	--	200	--	Marathon limestone	--	--	C,W	D	Old well.
L-99	Frank Wedin	Frank Wedin	--	360	--	Marathon(?) limestone	97.8	Oct. 29, 1956	C,E, 2	P	One of 2 wells supplying 30 homes and a few stores.
L-100	do	do	--	400	8	do	98.8	do	C,E	P	One of 2 wells supplying 30 homes and a few stores. Altitude of land surface 4,055.6 ft.
L-101	L. C. Ritchey	A. Burnham	--	--	--	do	101.3	Aug. 3, 1956	C,W	D	Old well.
L-102	Southern Pacific Lines	R. Owens	1911	203	12	Marathon limestone	91.6	Jan. 14, 1957	T,E, 15	RR	Casing: 12-in. to 20 ft. Discharge reported 50 gpm. in 1956.
*L-103	do	do	1892	316	10	do	93.0	do	T,E	RR	Originally dug to 109 ft.; deepened to 316 ft. in 1911.
L-104	-- Johnson	G. W. Hargus	--	185	--	do	102.7	Sept.27, 1956	C,E	D	Supplies water for tavern and tourist court.
L-105	L. S. Dickson	do	1945	195	--	do	127.8 125.3	Sept.24, 1956 Dec. 13, 1956	C,W	D	Altitude of land surface 4,082.5 ft.
*L-106	J. A. McGonagil	do	1941	168	10	do	116.3	Sept.21, 1956	N	N	Altitude of land surface 4,073.8 ft. Temp. 69°F. See figure 5.
L-107	--	--	--	--	6	--	--	--	N	N	
L-108	George Page	-- Chambers	--	--	8	Marathon(?) limestone	--	--	C,W	D	
L-109	E. A. Wilson	G. W. Hargus	--	120	--	Marathon limestone	--	--	C,W	D	Old well.
L-110	Lorraine Ellison	do	1931	185	--	do	93.1 90.9	Oct. 5, 1956 Dec. 12, 1956	C,W	D	Altitude of land surface 4,048.1 ft.
L-111	Frank Wedin	A. Burnham	--	130	--	do	--	--	C,W	D	Supplies water for 5 families. Old well.
L-112	Earl Pierson	--	--	--	--	Marathon(?) limestone	--	--	C,W	D	Oil contamination reported.
L-113	--	--	--	--	6	--	--	--	N	N	Discharge reported 400 gpm.
L-114	Bob Lemons	-- Stewart	--	130	--	Marathon limestone	--	--	C,W	D	

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level		Method of lift	Use of water	Remarks
							Below land surface datum (ft.)	Date of measurement			
L-115	Jeff Stewart	Guy Lee	--	180	8	Marathon limestone	57.6 57.8	Sept.26, 1956 Dec. 13, 1956	C,E, 3/4	D	Altitude of land surface 4,017.6 ft.
L-116	Jesse H. Hollis	-- Wagner	1956	130	6	do	68.9	Nov. 8, 1956	C,W	S	Altitude of land surface 4,028.3 ft.
L-117	Domingo Briseno	G. W. Hargus	1955	130	--	do	81.7	Sept.26, 1956	C,W	D	Altitude of land surface 4,038.4 ft.
L-118	Salvador Fuetez	Frank Wedin	--	135	--	do	78.0 78.2	Nov. 2, 1956 Dec. 13, 1956	C,W	D	Altitude of land surface 4,035.8 ft.
L-119	Secundino Ramos	--	1955	--	5	Marathon(?) limestone	82.3	Nov. 2, 1956	C,E, 1	D	
L-120	Cruz Cordova	G. W. Hargus	1952	150	6	Marathon limestone	85.9	do	C,E, 1	D	
L-121	Patricio Reos	-- Wagner	--	150	7	do	85.3	do	C,W	D	
L-122	Emilio Salmon	G. W. Hargus	1956	150	6	--	91.5	Sept.25, 1956	N	N	
L-123	Juan Salmon	do	1948	190	6	Marathon limestone	--	--	C,W,E	D	
L-124	Manuel Aquilar	Frank Wedin	1936	--	--	Marathon(?) limestone	--	--	C,W	D	
L-125	Mike Schodt	G. W. Hargus	1931	145	--	Marathon limestone	90.4	Oct. 8, 1956	C,W	D	Supplies water for 7 families.
L-126	Frank Valenzuela	--	--	90	--	do	86.1	Oct. 26, 1956	C,W	D	Altitude of land surface 4,042.6 ft.
L-127	do	--	--	--	--	Marathon(?) limestone	85.6	do	C,W	D	
L-128	Antonio Villareal	--	--	180	6	Marathon limestone	88.3	Oct. 5, 1956	C,W	D	
L-129	G. Terrazas	-- Parker	1922	--	--	Marathon(?) limestone	98.2	Nov. 2, 1956	C,E, 1	D	
L-130	Marcos Garcia	G. W. Hargus	1954	220	--	Marathon limestone	103.4 102.5	Sept.26, 1956 Dec. 11, 1956	C,W	D	Altitude of land surface 4,059.1 ft.
L-131	Juan Salmon	do	1950	135	6	do	94.2	Sept.25, 1956	C,W,E	D	

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
L-132	E. Aguilar	--	--	150	6	Marathon limestone	99.4 100.0	Aug. 6, 1956 Dec. 13, 1956	C,W	D	Altitude of land surface 4,056.8 ft.
L-133	Frank Wedin	A. Burnham	--	130	6	do	96.0	Sept.25, 1956	C,W	D	Altitude of land surface 4,052.9 ft.
L-134	do	do	1905	130	--	do	--	--	C,W	D	
L-135	G. O. Rutledge	Isaac Stewart	1946	150	7	do	96.2 95.9	Sept.25, 1956 Dec. 13, 1956	C,W	D	Altitude of land surface 4,052.9 ft.
L-136	Juan Villa	--	--	--	6	Marathon(?) limestone	115.6	Sept.26, 1956	C,W,G	D	
L-137	Ambrosio Galindo	-- Wagner	1955	150	7	Marathon limestone	115.1	Nov. 2, 1956	C,W	D	
L-138	Frank Wedin	A. Burnham	--	180	8	--	--	--	C,W	N	Old well.
L-139	J. R. Adams	G. W. Hargus	--	110	--	Marathon limestone	103.7	Oct. 5, 1956	C,E	D,S	Discharge reported 35 gpm in 1956. Old well.
L-140	Mrs. L. Dragoo	--	1913	--	10	--	105.5	Oct. 1, 1956	C,W	N	
L-141	Mrs. George Page	A. Burnham	1905	150	6	Marathon limestone	106.7	Sept.25, 1956	C,W	D	
L-142	Mrs. Lillie Burdwell	--	--	160	6	do	116.2 115.2	Oct. 1, 1956 Dec. 13, 1956	C,W	D	Altitude of land surface 4,072.3 ft.
L-143	Tom Yarbro	G. W. Hargus	1953	236	8	do	114.0	Aug. 6, 1956	C,E	D	
L-144	Combs Post Ranch	--	--	--	6	Marathon(?) limestone	114.1 113.8	Oct. 29, 1956 Dec. 11, 1956	C,W	S	Altitude of land surface 4,071.1 ft. Old well. Graveyard well.
L-145	Forker-Gage Ranch	G. W. Hargus	--	350	6	do	126.2 126.1	Oct. 4, 1956 Dec. 11, 1956	C,W	S	Altitude of land surface 4,083.5 ft. Town Mill well.
*L-146	Dow Chemical Co.	do	1956	502	8	Fort Peña formation and Marathon limestone	136.2	Dec. 9, 1956	N	N	Temp. 72°F. 1/
*L-147	Forker-Gage Ranch	--	1955	145	6	--	98.2 100.3	Oct. 4, 1956 Dec. 13, 1956	C,W	S	Waggoner well. Temp. 70°F.
L-148	Dow Chemical Co.	G. W. Hargus	1956	446	--	--	55.5 56.3	Dec. 21, 1956 Jan. 11, 1957	N	N	Drilled in Woods Hollow shale to total depth.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
L-149	Combs Post Ranch	G. W. Hargus	1945	--	6	Fort Peña(?) formation	152.0	Nov. 9, 1956	C,W	S	Airport well.
L-150	do	--	1956	9,000?	--	--	--	--	N	N	Oil-test well. Gulf Oil Co.-D. S. Combs well 1.
L-151	do	--	1956	230	10	--	88.3 88.1	Nov. 23, 1956 Dec. 13, 1956	N	N	Discharge reported 25 gpm in 1956. Altitude of land surface 4,104.5 ft.
*L-152	do	--	--	66	--	--	42.2 42.5	Nov. 6, 1956 Dec. 11, 1956	C,W	S	Altitude of land surface 4,058.4 ft. 3-section well. Temp. 68°F. Old well.
*L-153	Forker-Gage Ranch	--	--	147	--	Tesnus(?) formation	89.7	Dec. 13, 1956	C,W	S	Altitude of land surface 4,173.5 ft. 4-Mile well. Temp. 69°F.
L-154	Combs Post Ranch	--	--	--	--	--	61.4 61.2	Nov. 9, 1956 Dec. 13, 1956	C,W	S	Altitude of land surface 4,132.8 ft. Old well. Lake well.
L-155	do	G. W. Hargus	1945	150	6	--	44.5 45.4	Nov. 9, 1956 Dec. 13, 1956	C,W	S	Altitude of land surface 4,103.0 ft. New Lake well.
L-156	Catto-Gage Ranch	do	1954	100	7	Tesaus(?) formation	24.3 25.7	Dec. 13, 1956 Aug. 26, 1957	C,W	S	Altitude of land surface 4,075.7 ft. Temp. 70°F.
M-1	Combs-Kincaid Ranch	--	--	104	6	--	70.1	Nov. 9, 1956	C,W	S	Hess well.
M-2	Bill Neal	--	--	80	6	--	--	--	C,W	S	
M-3	Combs-Kincaid Ranch	--	--	200	6	--	61.7	Nov. 9, 1956	C,W	S	Old well. Valley well.
M-4	do	--	--	40	6	Quaternary rocks	14.8	Nov. 16, 1956	C,W	S	Old well. WB well.
M-5	do	G. W. Hargus	1951	75	6	do	35.4	Nov. 9, 1956	C,W	D	Cased to bottom.
M-6	do	do	1951	100	6	Quaternary(?) rocks	--	--	C,W	S	
*M-7	do	--	--	175?	6	--	58.2	Nov. 13, 1956	C,W	S	Granger well. Temp. 64°F. See figure 5.
M-8	do	--	--	160	6	--	--	--	C,W	S	Star well. Old well.
M-9	do	--	--	60	6	Quaternary(?) rocks	28.0	Nov. 13, 1956	C,W	S	Cased to bottom. Martin well. Old well.
M-10	Forker-Gage Ranch	--	--	85	--	do	44.3	Oct. 5, 1956	C,W	S	North Beckley well.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
M-11	Combs-Kincaid Ranch	G. W. Hargus	1952	100	6	--	41.4	Nov. 15, 1956	C,W	S	Water reported high in sulfate content. Pocket well.
M-12	do	do	1946	150	6	Tesnus(?) formation	--	--	C,W	S	Lake well.
M-13	do	--	--	40	6	Quaternary(?) rocks	36.5	Nov. 13, 1956	C,W	S	Stewart well. Old well.
M-14	do	--	--	80	6	do	56.1	Nov. 16, 1956	C,W	S	Burned house well. Old well.
M-15	do	--	--	40	6	Tesnus formation	35.4	Nov. 15, 1956	C,W	S	Old Taylor well. Old well.
M-16	do	G. W. Hargus	1948	125	7	do	120.1	do	C,W	S	New Taylor well.
M-17	do	do	--	100	6	Quaternary(?) rocks	56.2	Nov. 16, 1956	C,W	S	McGee well. Old well.
M-18	do	--	--	80	8	do	36.4	Nov. 13, 1956	C,W	S	Black Muley well. Old well.
M-19	do	G. W. Hargus	1944	50	6	do	26.4	Nov. 15, 1956	C,W	S	Little Black Muley well.
M-20	do	Guy Lee	1944	80	6	Tesnus formation	39.6	Nov. 13, 1956	C,W	S	Shearing trap well.
M-21	do	--	--	80	7	Quaternary(?) rocks	41.3	Nov. 15, 1956	C,W	S	Stillwell well. Old well.
M-22	Forker-Gage Ranch	--	--	54	--	Tesnus formation	20.0	Oct. 6, 1956	C,W	S	Yarbro well.
M-23	do	--	--	60	--	Quaternary(?) rocks	28.9	Oct. 4, 1956	C,W	S	East Beckley well.
M-24	do	--	--	70	--	do	35.0	do	C,W	S	Ansley well.
M-25	do	--	--	34	--	do	20.2	Oct. 6, 1956	C,W	S	Simpson-Flat pasture well.
M-26	--	--	--	--	5	--	30.9	Oct. 18, 1956	N	N	See figure 5.
M-27	Forker-Gage Ranch	--	--	57	6	Quaternary(?) rocks	29.2	Oct. 6, 1956	C,W	S	Walker well.
M-28	do	--	--	200	--	--	153.7	Oct. 9, 1956	C,W	S	Pulliam well.
M-29	do	--	--	53	--	Quaternary(?) rocks	39.6	Oct. 5, 1956	C,W	S	Nichols well.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
M-30	Forker-Gage Ranch	--	--	90	--	Quaternary(?) rocks	26.8	Oct. 5, 1956	C,W	S	Causey well.
M-31	do	--	--	40	6	Quaternary rocks	8.3	Oct. 8, 1956	C,W	S	Kriegbaum well.
M-32	do	--	--	135	--	--	85.0	do	C,W	S	East Pulliam well.
M-33	do	--	--	25	6	Quaternary rocks	19.2	do	C,W	S	Simpson (Kriegbaum trap pasture) well.
M-34	do	--	--	100	6	--	18.3	do	C,W	S	East Cove well.
*M-35	do	--	--	75	6	Quaternary(?) rocks	38.6	Oct. 6, 1956	C,W	S	South Bennett well. Temp. 68°F.
M-36	do	--	--	--	6	do	38.4	do	C,W	S	Bennett well.
M-37	do	--	--	64	6	do	36.1	do	C,W	S	Matthews well.
M-38	do	--	--	30	--	do	24.8	do	C,W	S	Simpson (South Bennett pasture) well.
M-39	do	--	--	30	--	--	--	--	C,W	S	McFarland well.
P-1	Catto-Gage Ranch	--	--	Spring	--	--	(+)	Aug. 22, 1957	Flows	S	
P-2	do	G. W. Hargus	1940	250	6	--	203.1	Aug. 10, 1957	C,W	S	Chalk Valley well.
Q-1	do	do	1919	3,500	--	Dimple limestone	160	1957	C,W	S	Originally an oil-test well.
Q-2	do	do	1949	125	6	--	23.7	Aug. 21, 1957	C,W	S	Dugout Gap well.
Q-3	do	-- Bennett	1915	125	6	Dimple limestone	100	1957	C,W	S	Double Mills well.
Q-4	do	do	--	--	7	--	23.6	Aug. 9, 1957	N	N	
Q-5	do	G. C. Parker	1921	150	6	--	125	1957	C,W	S	Twin China well.
*Q-6	do	--	--	Spring	--	Edwards limestone	(+)	Mar. 5, 1957	Flows	S	Flow estimated 40 gpm Mar. 5, 1957. Doubtful Spring. Temp. 62°F.
Q-7	Travis Roberts	G. W. Hargus	1950	100	5	Quaternary rocks	33.6	Aug. 28, 1957	C,W	D	Reported strong supply.
Q-8	Mrs. Katie Roberts	do	1942	75	6	do	22.9	do	C,W	S	do
Q-9	do	do	1931	300	--	--	25	1957	C,W	S	
*Q-10	do	Frank Wedin	1939	100	6	Quaternary rocks	26.4	Aug. 28, 1957	C,W	S	Temp. 68°F.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
Q-11	J. J. Roberts	G. W. Hargus	1931	40	6	Quaternary rocks	33.7	Aug. 19, 1957	C,W	D,S	Reported strong supply.
Q-12	Travis Roberts	--	1916	20	6	do	--	--	C,W	S	Dipping Vat well.
Q-13	J. J. Roberts	Frank Wedin	1939	100	6	--	25.0	Aug. 28, 1957	C,W	S	
Q-14	do	Milo Bennett	1929	300	8	--	101.1	do	C,W	S	
Q-15	Mrs. Katie Roberts	--	--	Spring	--	Edwards limestone	(+)	do	Flows	S	Flow measured ½ gpm Aug. 28, 1957. Fluctuates seasonally.
Q-16	Catto-Gage Ranch	George McSpadden	1928	150	6	Tesnus formation	109.2	Aug. 22, 1957	C,W	S	Lower Road Canyon well.
Q-17	do	--	--	Spring	--	Ordovician rocks	(+)	Aug. 9, 1957	Flows	S	Flow estimated 20 gpm Aug. 9, 1957. Monument Spring. Temp. 75°F.
Q-18	Mrs. Katie Roberts	Milo Bennett	1930	300	8	--	150	1957	N	N	
Q-19	D. S. Combs	--	--	Spring	--	Ordovician & Quaternary rocks	(+)	July 31, 1956	Flows	S	Flow estimated 25 gpm July 31, 1956. Rock House Spring.
Q-20	Mrs. -- McGee	--	--	294	6	Dimple(?) limestone	88.5	Sept. 6, 1957	C,W	S	
Q-21	D. S. Combs	G. W. Hargus	1955	40	--	Tesnus formation	--	--	C,W	S	
Q-22	do	do	1956	42	6	Quaternary rocks	--	--	C,W	S	
Q-23	do	--	--	30	6	do	--	--	C,W	S	Mather House well. Old well.
Q-24	do	--	--	50	36	do	17.1	Sept. 6, 1957	C,W	D	Dug. Old well.
R-1	Catto-Gage Ranch	Frank Wedin	1937	100	6	do	31.2	Aug. 22, 1957	C,W	S	Cartwright well.
R-2	Combs Post Ranch	--	--	100	6	do	15.7	Oct. 19, 1956	C,W	D,S	
*R-3	do	G. W. Hargus	1950	125	6	Ordovician & Quaternary rocks	11.4	Nov. 9, 1956	C,W	S	Altitude of land surface 3,934.1 ft. Salt Grass well. (See figure 5.) Temp. 67°F.
*R-4	Brewster County	--	--	Spring	--	do	(+)	July 31, 1956	Flows	N	Estimated range in flow 150 to 450 gpm during 1957. Peña Colorada Spring. Temp. 58°F.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
R-5	Brewster County	--	--	--	48	Ordovician & Quaternary rocks	7.0 6.7	Nov. 6, 1956 Dec. 12, 1956	C,W	P	Dug. Altitude of land surface 3,872.2 ft. Wooden curb. In county park.
R-6	Catto-Gage Ranch	Frank Wedin	1939	300	6	--	41.9	Aug. 22, 1957	C,W	S	Mouth of Road Canyon well.
R-7	do	--	--	Spring	--	Caballos novaculite	(+)	Aug. 26, 1957	Flows	S	Flow estimated 5 gpm from seeps at top of novaculite. Sunshine Springs. Temp. 84°F.
R-8	do	G. W. Hargus	1943	50	6	Quaternary rocks	20	Aug. 1957	C,W	S	Buena Vista well.
R-9	Combs Post Ranch	--	1956	100	6	Tesnus formation	11.1 11.3	Nov. 9, 1956 Dec. 13, 1956	C,W	S	Casing: 6-in. to 80 ft. Altitude of land surface 4,060.0 ft. Causey well.
R-10	Catto-Gage Ranch	G. W. Hargus	1942	100	--	do	30.6	Aug. 26, 1957	C,W	S	Causey well.
R-11	do	Frank Wedin	1936	100	--	--	20.3	do	C,W	S	
R-12	do	E. Meeks	1913	125	6	--	79.6	do	C,W	S	Reported strong supply. 7-Mile well. Temp. 71°F.
R-13	Earl Clark	G. W. Hargus	1954	120	6	Tesnus formation	50	1957	C,W	S	Reported weak supply.
R-14	do	do	1956	92	7	do	38	1957	C,W	S	Reported strong supply.
R-15	do	do	1946	40	10	Quaternary rocks	20	1957	C,W	D,S	Originally dug to 22 ft. Reported strong supply.
R-16	do	do	1946	120	8	--	18	1957	T,G, 23	Irr	Discharge reported 70 gpm in 1957.
R-17	Catto-Gage Ranch	do	1943	150	6	Tesnus formation	89.1	Aug. 26, 1957	C,W	S	Mud Spring well.
R-18	do	do	1943	125	--	Quaternary rocks	48.2	do	C,W	S	10-Mile well.
R-19	Earl Clark	do	1940	40	7	Tesnus formation	18	1957	C,W	S	Reported strong supply. Orchard well.
R-20	D. S. Combs	--	--	Spring	--	Caballos novaculite	(+)	Sept. 5, 1957	Flows	S	Flow estimated 3 gpm Sept. 5, 1957. Simpson Springs. Temp. 74°F.
R-21	do	--	1940	150	5	Tesnus formation	97.7	do	C,W	S	Peña well.
R-22	Earl Clark	G. W. Hargus	1949	125	6	do	80	1957	C,W	S	
R-23	D. S. Combs	E. Meeks	--	80	6	do	63.7	Aug. 29, 1957	C,W	S	Old well. Beef Pasture well.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
R-24	D. S. Combs	--	1940	150	6	Fort Peña formation	76.6	Sept. 5, 1957	C,W	S	3-Gate well.
R-25	Catto-Gage Ranch	G. W. Hargus	1956	100	7	--	87.3	Aug. 27, 1957	C,W	S	Ridge Spring well.
R-26	do	--	--	Spring	--	--	(+)	do	Flows	S	Flow estimated 2 gpm Aug. 27, 1957. Fluctuates seasonally. Garden Springs.
R-27	D. S. Combs	--	--	24	--	Quaternary rocks	17.6	Sept. 5, 1957	C,W	S	Dug. Concrete curb. Hatch well.
R-28	Harvey & Howard Hatch	Frank Wedin	1943	100	6	--	40	1957	C,W	D,S	
R-29	Forker-Gage Ranch	I. Stewart	1947	220	8	Fort Peña formation	150.0	Oct. 9, 1956	C,W	S	Woods Hollow well.
R-30	do	G. W. Hargus	1935	1,617	8	--	268.2	do	C,W	S	Casing: 8-in. to 910 ft. Originally an oil-test well. King & Franklin-Gage No. 1. 1/
R-31	Catto-Gage Ranch	Frank Wedin	1938	150	6	Tesnus formation	101.8	Aug. 27, 1957	C,W	S	Reported strong supply. Upper Woods Hollow well.
R-32	do	G. W. Hargus	1948	150	7	--	86.1	do	C,W	S	Woods Hollow horse trap well.
*R-33	do	-- Clark	1935	125	--	Tesnus formation	100.3	do	C,W	S	WH well. Temp. 72°F.
R-34	do	Frank Wedin	1937	150	6	--	86.0	do	C,W	S	Partition well.
R-35	Gage Holland	-- Meeks	1911	150	--	--	92.8	Sept.16, 1957	C,W	S	Dagger Flat well.
R-36	D. S. Combs	--	--	100	6	--	--	--	C,W	S	Buttrill well.
R-37	Buttrill Estate	G. W. Hargus	1957	140	6	Marathon limestone	--	--	C,W	S	Discharge reported 35 gpm when tested. North 2-section well. Temp. 74°F.
R-38	Gage Holland	--	--	--	6	--	67.9	Sept.16, 1957	C,W	S	Barrett well.
R-39	Catto-Gage Ranch	G. W. Hargus	1949	125	--	--	63.0	Aug. 27, 1957	C,W	S	Reported strong supply.
R-40	--	do	--	150	--	Tesnus formation	131.9	Aug. 8, 1957	C,W	S	Horseshoe Mountain well.
R-41	Gage Holland	E. Meeks	1912	--	--	do	79.5	Aug. 27, 1957	C,W	S	Hackberry well.
S-1	Forker-Gage Ranch	--	--	110	7	--	87.7	Oct. 19, 1956	C,W	S	Road well.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
S-2	Forker-Gage Ranch	--	--	--	5	--	--	--	C,W	D,S	Lightning well.
S-3	do	--	--	50	--	Quaternary(?) rocks	--	--	C,W	S	Peña Blanca well.
S-4	Gage Holland	--	--	150	6	do	--	--	C,W	S	do
*S-5	do	--	--	Spring	--	Ordovician & Quaternary rocks	(+)	Mar. 5, 1957	Flows	S	Flow estimated 20 gpm Mar. 5, 1957. Peña Blanca Spring. Temp. 62°F. Fluctuates seasonally.
S-6	do	G. W. Hargus	1951	190	7	--	95.2	Sept.16, 1957	C,W	S	Bee Sting well.
S-7	Forker-Gage Ranch	--	--	57	6	Tesnus formation	43.7	Oct. 19, 1956	C,W	S	Alfred Trap well.
S-8	do	--	--	169	7	do	129.7	Oct. 17, 1956	C,W	S	Lightning Trap well.
S-9	do	--	--	139	6	do	117.3	Oct. 16, 1956	C,W	S	Shipping Trap well.
S-10	do	--	1951	50	6	do	28.6	Oct. 8, 1956	C,W	S	Haymond well.
S-11	Southern Pacific Lines	--	--	20	--	Quaternary rocks	--	--	C,W	RR	Old well.
S-12	Mary Pierson	J. J. Miller	1925	96	--	Tesnus formation	63.8	Sept.17, 1957	C,W	D,S	Reported strong supply.
S-13	Gage Holland	G. W. Hargus	1938	--	6	Quaternary(?) rocks	31.7	do	C,W	S	Reported strong supply. Arden Draw well.
S-14	do	do	1954	50	7	Tesnus formation	26.0	do	C,W	S	Toe well.
S-15	do	do	1950	200	7	do	82.0	Sept.16, 1957	C,W	S	Boose well.
S-16	do	--	--	Spring	--	Caballos novaculite	(+)	Mar. 13, 1957	Flows	S	Flow estimated 5 gpm Mar. 13, 1957. Reed Spring.
*S-17	do	--	--	100	7	Tesnus formation	33.3	Nov. 23, 1956	C,W	S	Reed well. Temp. 70°F.
S-18	do	G. W. Hargus	1951	200	7	--	107.7	Sept.16, 1957	C,W	S	Saddle well.
S-19	do	do	1957	98	6	Tesnus formation	67.9	do	C,W	S	101 well.
S-20	do	--	--	--	--	--	--	--	C,W	S	Horse Mountain well.
S-21	do	--	--	--	--	Quaternary(?) rocks	--	--	C,W	S	Shaky well.

* See footnotes at end of table.

Table 2.--Records of wells and springs in the Marathon area, Brewster County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft.)	Diameter of well (in.)	Water-bearing unit	Water level: Below land surface datum (ft.)	Water level: Date of measurement	Method of lift	Use of water	Remarks
S-22	Gage Holland	--	--	140	6	--	--	--	C,W	N	Border well.
S-23	do	--	--	--	--	--	95.9	Sept.16, 1957	C,W	S	Fred Rice well.
S-24	do	--	--	200	6	Tesnus formation	38.9	Sept.20, 1957	C,W	S	Dixon well.
S-25	do	G. W. Hargus	1946	80	6	Dimple(?) limestone	54.2	Sept.17, 1957	C,W	S	Granger Cove well.
S-26	do	do	1940	--	6	Tesnus formation	73.8	do	C,W	S	Reported weak supply. China Draw well.
S-27	do	do	1940	80	6	do	60.1	do	C,W	S	Nigger Creek well.
S-28	do	do	1950	50	7	do	9.6	do	C,W	S	
S-29	do	--	--	--	--	--	--	--	N	N	Oil-test well. Plugged and abandoned.
S-30	do	--	--	--	6	Tesnus formation	43.0	Sept.16, 1957	C,W	S	West 9-section well.

1/ See table 3 for drillers' logs of wells in the Marathon area, Brewster County.
* See table 4 for analyses of water from wells and springs in the Marathon area, Brewster County.

Table 3.--Lithologic logs of wells L-35, L-146, and R-30, Marathon area

Well L-35

Owner: -- Driller: --

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay, yellow, and boulders	42	42	Slate, hard, black	60	995
Sand, white, and coarse gravel	19	61	Slate, broken, and black sand	20	1,015
Sandstone, blue	21	82	Slate, blue	40	1,055
Boulders and shale	5	87	Sand, hard, gray	7	1,062
Shale, hard, blue	58	145	Slate, blue	28	1,090
Conglomerate	140	285	Sand, broken, and blue slate	40	1,130
Limerock, black	205	490	Lime, black	5	1,135
Sand, hard, gray	45	535	Slate, broken, blue	10	1,145
Sand, white (1 bbl water in 6 hr., gas show)	5	540	Lime, hard, black	15	1,160
Sand, very hard, white	30	570	Shells, blue, and slate	150	1,310
Lime, hard, black	100	670	Slate, black (hole caving)	40	1,350
Shale, sandy, black	30	700	Slate, light, and sand	55	1,405
Lime, black	80	780	Lime, black, and sand	20	1,425
Sand and slate	20	800	Slate	20	1,445
Shale, sandy, black	40	840	Lime, black, and sand	20	1,465
Chert, white	20	860	Sand, brown	15	1,480
Lime, hard, black	40	900	Sand, broken, and lime	60	1,540
Sand, hard, gray	10	910	Sand, hard	10	1,550
Crevice	3	913	Sand, broken, lime, and slate	65	1,615
Lime, hard, gray	12	925	No record	45	1,660
Slate, black	5	930	Lime, hard, gray	95	1,755
Sand, dry, gray	5	935	Shale, hard, blue	15	1,770

(Continued on next page)

Table 3.--Lithologic logs of wells L-35, L-146, and R-30, Marathon area--Continued

Well L-35--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Lime, hard, gray -------	20	1,790	Shell, hard ------------	7	2,684
Shale and lime shells --	60	1,850	Lime, black ------------	216	2,900
Sand, black ------------	10	1,860	Shale, sandy, hard, black	190	3,090
Slate and lime shells --	40	1,900	Lime, hard, brown ------	5	3,095
Shale, gray ------------	40	1,940	Lime, black ------------	5	3,100
Lime, black ------------	60	2,000	Shale, sandy, black ----	5	3,105
Lime, hard, black ------	10	2,010	Lime, black ------------	5	3,110
Lime, black ------------	285	2,295	Shale, sandy, black ----	185	3,295
Lime, hard, black ------	15	2,310	Shale, sandy, blue -----	55	3,350
Lime, black ------------	290	2,600	Lime, black ------------	5	3,355
Lime, hard, black ------	10	2,610	Shale, sandy, blue -----	190	3,545
Lime, black ------------	67	2,677	Lime, sandy, blue -------	120	3,665

Well L-146

Owner: Dow Chemical Co. Driller: G. W. Hargus.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
No record ------------	40	40	Shale, light-gray, calcareous, partly silty, laminated, and minor amount of dark-gray fine-grained limestone. (Water at 150 ft.) --	75	165
Woods Hollow shale:			Shale, gray, calcareous, 80 percent; 20 percent of white and dark-gray, mostly fine-grained, slightly sandy limestone -----	25	190
Shale, yellow, light-brown, and gray, partly calcareous, silty, laminated, about 70 percent; about 30 percent of tan and light- to dark-gray mostly fine-grained limestone. (Water entered hole at 48 ft. and rose to 26 ft. below land surface.) -------	50	90			

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Table 3.--Lithologic logs of wells L-35, L-146, and R-30, Marathon area--Continued

	Thickness (feet)	Depth (feet)
Well L-146--Continued		
Limestone, light- to dark-gray, gray silty slightly calcareous shale and light-gray fine-grained sandstone in calcareous matrix-	25	215
Shale, gray, slightly calcareous; minor amount of light-gray limestone and gray calcareous siltstone; traces of pyrite, glauconite, quartz, and white calcite ---	35	250
Fort Peña formation:		
Limestone, very light gray, fine-grained to fine medium-grained; dark-gray hard shale; transparent purple chert; traces of pyrite --------------	8	258
Shale, silty, hard, dark-gray, and light-gray and tan fine-grained limestone; traces of chert and pyrite (water at 270 ft.) ----------------	12	270
Chert, transparent, has purple tinge; light-gray and tan limestone, dark-gray hard silty shale; traces of pyrite and white calcite -------------	10	280
Siltstone, calcareous, laminated, brown; light-gray and light-brown sandy limestone; gray and yellow calcareous shale; traces of chert, pyrite, and calcite -------------	20	300
Limestone, white, gray, and yellow ----------	5	305
Siltstone, dark-gray -	5	310
Chert, transparent purple; limestone, siltstone, and some gray shale; trace of pyrite --------------	10	320
Limestone, light-gray, some gray shale, chert, smoky quartz, and calcite -------------	10	330
Sandstone, fine- to medium-grained, calcareous, yellowish-gray; siltstone, silty shale, and some limestone ------	10	340
Limestone, light-gray, mostly fine-grained; some conglomerate containing shaly siltstone, fine-grained quartz sandstone, limestone, chert, and crystalline calcite. (Water at 370 ft.; static level 136 ft. below land surface)	46	386

(Continued on next page)

Table 3.--Lithologic logs of wells L-35, L-146, and R-30, Marathon area--Continued

Well L-146--Continued

	Thickness (feet)	Depth (feet)
Siltstone, shaly, slightly calcareous, dark-gray; limestone and chert	4	390
Alsate shale:		
Siltstone, slightly calcareous, partly sandy, dark-gray; white to dark-gray limestone	25	415
Limestone, light- to dark-gray, mostly fine-grained, interbedded with dark-gray calcareous siltstone	32	447
Marathon limestone:		
Limestone, medium-gray, fine-grained; traces of siltstone and quartz sand. (Additional water entered hole; no change in static level.)	55	502

Well R-30

Owner: Forker-Gage Ranch. Driller: G. W. Hargus.

	Thickness (feet)	Depth (feet)
Fort Peña formation:		
Sandstone, gray and brown	67	67
Limestone, gray	27	94
Shale, green	4	98
Limestone, gray (water)	16	114
Alsate shale:		
Limestone, shale, and chert, brown, gray, and white	26	140
Shale, dense, gray and black	234	374
Shale, dark-gray, and gray limestone	91	465
Marathon limestone:		
Limestone, gray; chert cement; shale, some sandstone, and vein of quartz. (Water at 475 ft.)	24	489
Shale, gray, brown sandstone, light grayish-green bentonite and gray limestone	161	650
Shale, black, gray limestone, and light-gray and brown sandstone	73	723
Dolomite and white chert	2	725
Dolomite, cream-colored	4	729

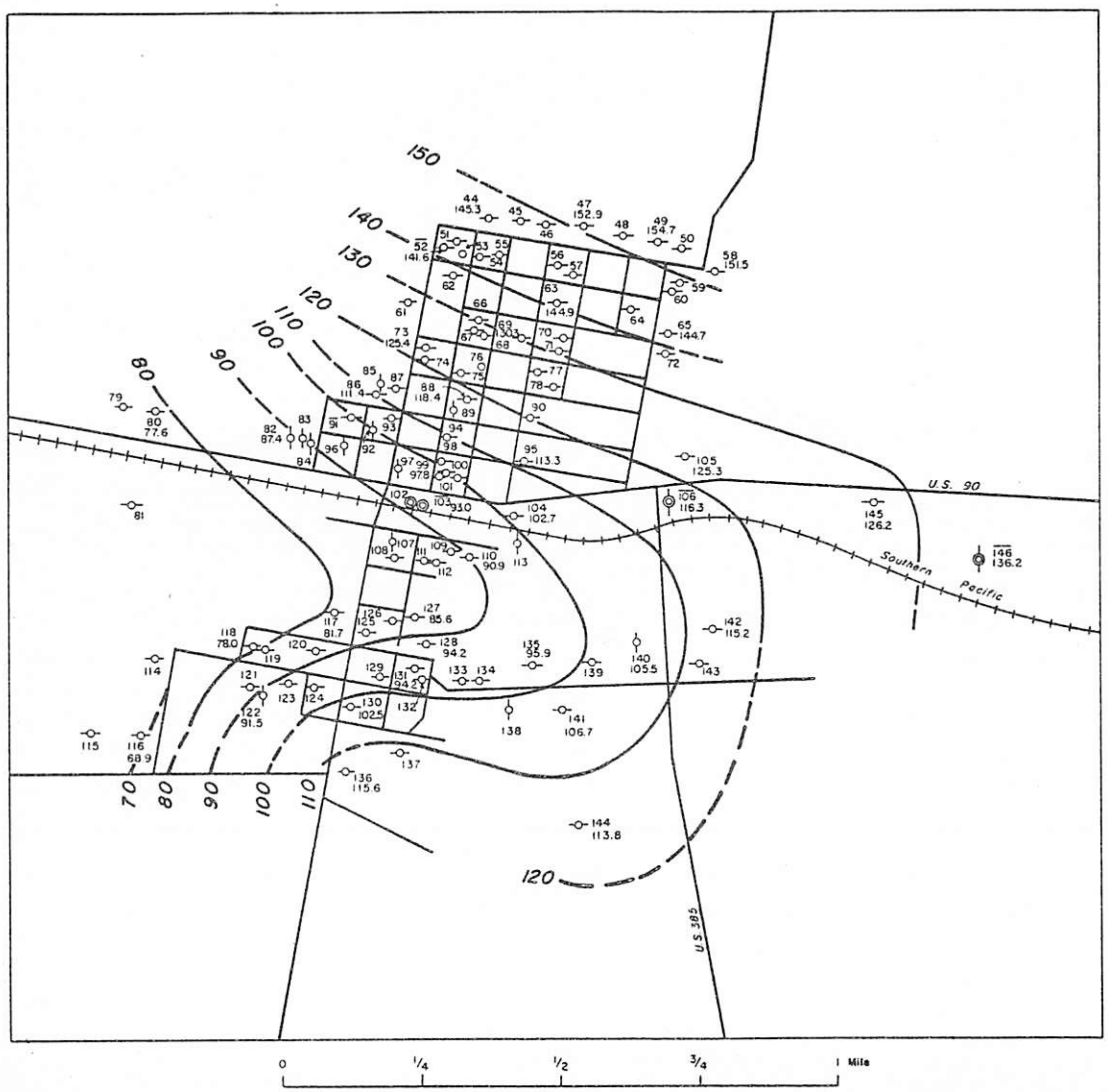
(Continued on next page)

Table 3.--Lithologic logs of wells L-35, L-146, and R-30, Marathon area--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well R-30--Continued					
Sandstone, gray ------	2	731	Limestone, conglomerate, and some pebbles ----	12	922
Limestone and some gray shale ----------	8	739	Limestone, gray ------	20	942
Limestone, some sandstone and quartz. (Water at 742 ft.) --	3	742	Shale, dark-gray -----	4	946
Shale, black and gray-	10	752	Limestone, gray ------	9	955
Sandstone, gray ------	3	755	Shale, black and gray-	17	972
Limestone, gray ------	4	759	Limestone, gray ------	14	986
Sandstone, gray, and some gray limestone -	11	770	Shale, gray ----------	26	1,012
Dolomite, fine-grained, light-gray ----------	9	779	Limestone, gray and light-brown ---------	54	1,066
Chert, white ---------	3	782	Limestone, pyrite, and some chert ----------	13	1,079
Dolomite, some shale, and gray limestone --	12	794	Chert, black ---------	7	1,086
Sandstone, limy, light-gray (water) --------	4	798	Chert, light-gray; some lime streaks ---	29	1,115
Sandstone, lime cement	12	810	Chert, light-brown; some dolomite -------	48	1,163
Limestone, dark-gray -	5	815	Chert, black ---------	6	1,169
Shale, limy, dark-gray	24	839	Bentonite, green, and some light-gray chert	16	1,185
Shale, limy, and some chert --------------	12	851	Chert, grayish-white with streaks of black	36	1,221
Shale, black; some fine limestone ------	19	870	Chert, white; some bentonite and pyrite-	41	1,262
Limestone, black -----	6	876	Chert, white, with streaks of blue, black, and brown; mostly clear white novaculite ----	355	1,617
Shale, dark-gray and blue ---------------	14	890			
Limestone, gray and brown ---------------	20	910			

Table 4.--Chemical analyses of water from selected wells and springs in the Marathon area, Brewster County
(In parts per million except specific conductance, pH, and percent sodium)

Well	Water-bearing formation	Depth of well (ft.)	Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	pH	Temperature (°F)
			1957																
G-9	Dimple limestone	100	Mar. 11	19	--	60	60	83	316	159	98	1.8	11	647	396	31	1,080	7.4	67
L-26	Gaptank formation	120	Mar. 12	30	--	67	34	40	429	17	6.5	1.2	19	426	307	20	707	7.6	66
L-31	--	250	Mar. 13	18	--	64	37	60	324	88	53	1.2	10	493	312	30	823	7.7	68
L-36	Gaptank formation	100?	Mar. 11	17	--	51	35	68	333	98	30	--	2.2	465	271	35	769	7.5	73
L-52	Marathon limestone	200	Mar. 9	16	--	68	46	82	322	123	98	1.8	3.0	596	358	37	1,020	7.5	68
L-91	do	165	do	18	0.06	265	184	327	522	16	1190	1.0	4.0	2,260	1,420	33	4,270	7.1	68
L-103	do	316	Jan. 22	43	--	88	52	92	323	52	215	1.4	9.4	741	434	31	1,270	7.3	--
L-106	do	168	Jan. 19	23	--	44	29	66	309	67	26	2.0	9.4	418	229	38	687	7.7	69
L-146	Fort Peña formation and Marathon limestone	502	Jan. 16	20	--	48	28	101	322	113	49	1.4	1.4	520	235	48	848	7.5	72
L-147	--	145	Mar. 13	16	--	52	23	73	284	83	42	1.2	1.8	432	224	41	718	7.5	70
L-152	--	66	Mar. 12	20	--	208	79	64	443	526	48	1.2	2.5	1,170	844	14	1,600	7.2	67
L-153	Tesnus formation(?)	147	do	16	--	16	11	164	285	121	38	6.0	14	534	85	81	846	8.0	69
M-7	--	175?	Mar. 11	14	--	64	48	167	325	254	128	2.8	.0	847	357	50	1,350	7.4	63
M-35	Quaternary rocks(?)	75	Mar. 12	22	--	60	11	108	332	98	37	.6	3.2	503	194	55	804	7.6	68
Q-6	Edwards limestone	Spring	Mar. 5	16	--	72	10	13	258	27	5.8	.6	.5	276	220	12	464	7.7	62
Q-10	Quaternary rocks(?)	100	do	24	--	74	30	56	357	107	16	.8	2.0	493	308	29	790	7.5	68
R-3	Ordovician and Quaternary rocks	125	Mar. 11	30	--	46	43	116	388	156	43	--	4.0	629	292	46	991	7.8	67
R-4	do	Spring	Mar. 12	10	--	60	48	92	374	166	42	2.2	1.8	606	347	36	971	8.1	57
R-33	Tesnus formation(?)	125	do	26	--	108	22	41	342	107	36	.8	5.0	533	360	20	828	7.2	--
S-5	Ordovician and Quaternary rocks	Spring	Mar. 13	6.4	--	74	25	24	219	141	7.8	.8	.0	406	288	15	617	7.8	62
S-17	Tesnus formation	100	do	24	--	67	32	50	356	90	13	.8	1.5	453	298	27	719	7.9	70



EXPLANATION

Well with windmill or small power plant

Well with pumping plant, 5-horsepower or larger

Unused well

15

Line above well number indicates that chemical analysis is included in report

Where two numbers are given, upper number is well number, lower number is depth to water, in feet

90

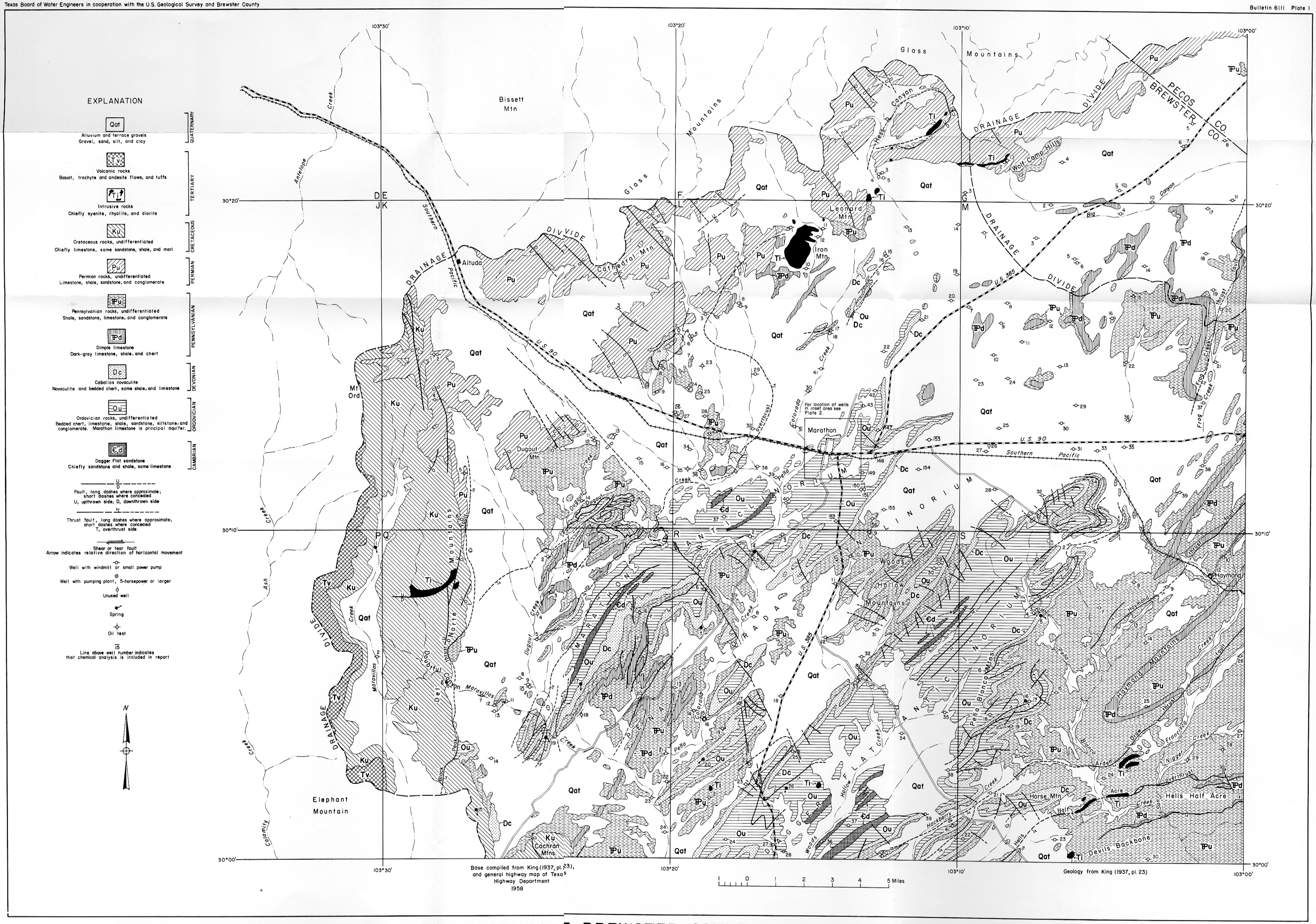
Line showing depth to water; dashed where approximately located

Contour interval, 10 feet

Datum is land surface

N

MAP OF MARATHON AND VICINITY SHOWING LOCATION OF WELLS AND DEPTH TO WATER, SEPTEMBER–DECEMBER 1956



GEOLOGIC MAP OF MARATHON AREA, NORTHEAST BREWSTER COUNTY, SHOWING LOCATION OF WELLS AND SPRINGS