HYDROLOGIC ATLAS 19

HYDROGEOLOGY OF THE CLAYTON AND CLAIBORNE AQUIFER SYSTEMS

by
Anna F. Long

GEORGIA DEPARTMENT OF NATURAL RESOURCES
J. Leonard Ledbetter, Commissioner

ENVIRONMENTAL PROTECTION DIVISION
Harold F. Reheis, Assistant Director

GEORGIA GEOLOGIC SURVEY
William H. McLemore, State Geologist

ATLANTA
1989

HYDROLOGIC ATLAS 19

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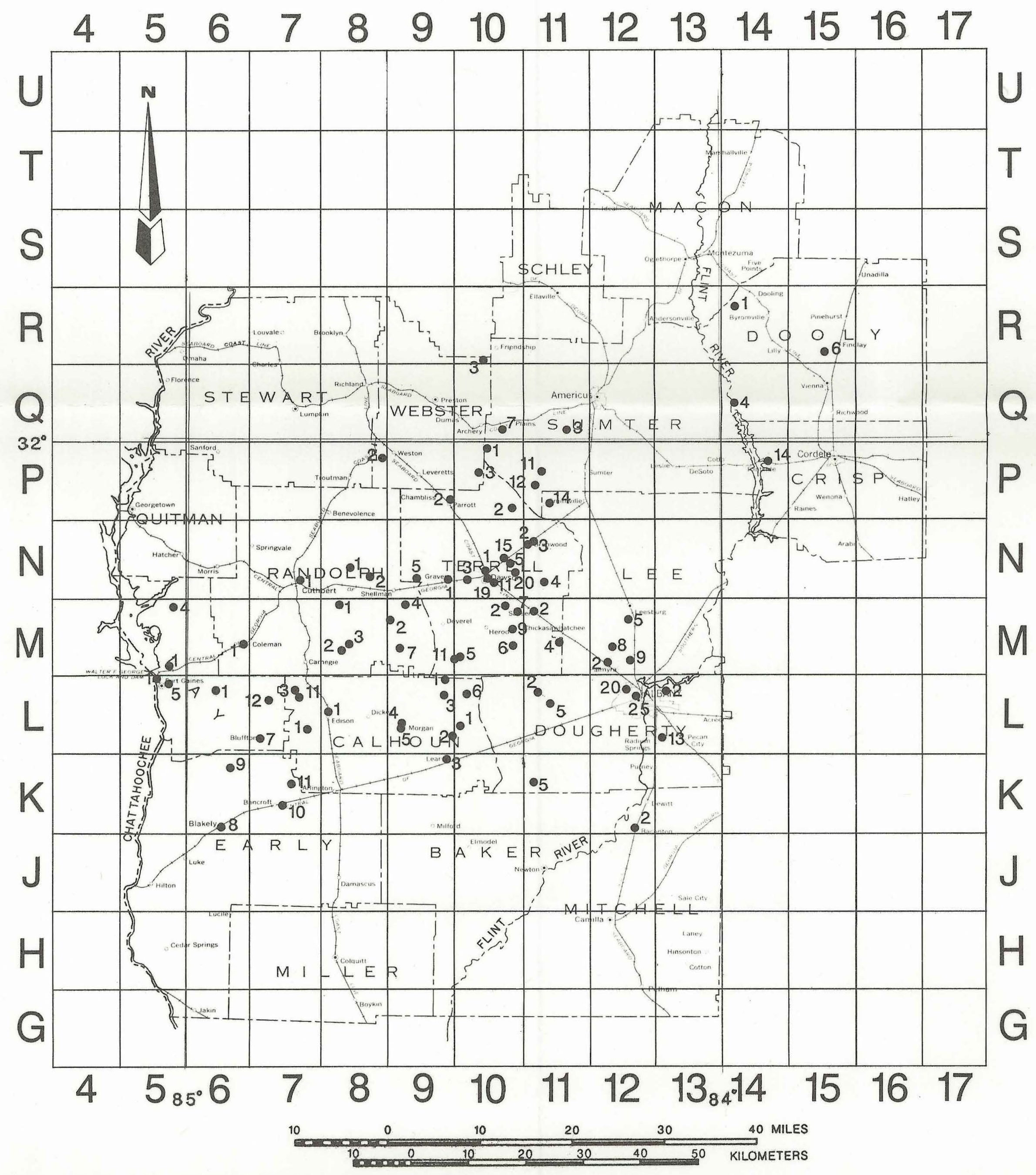
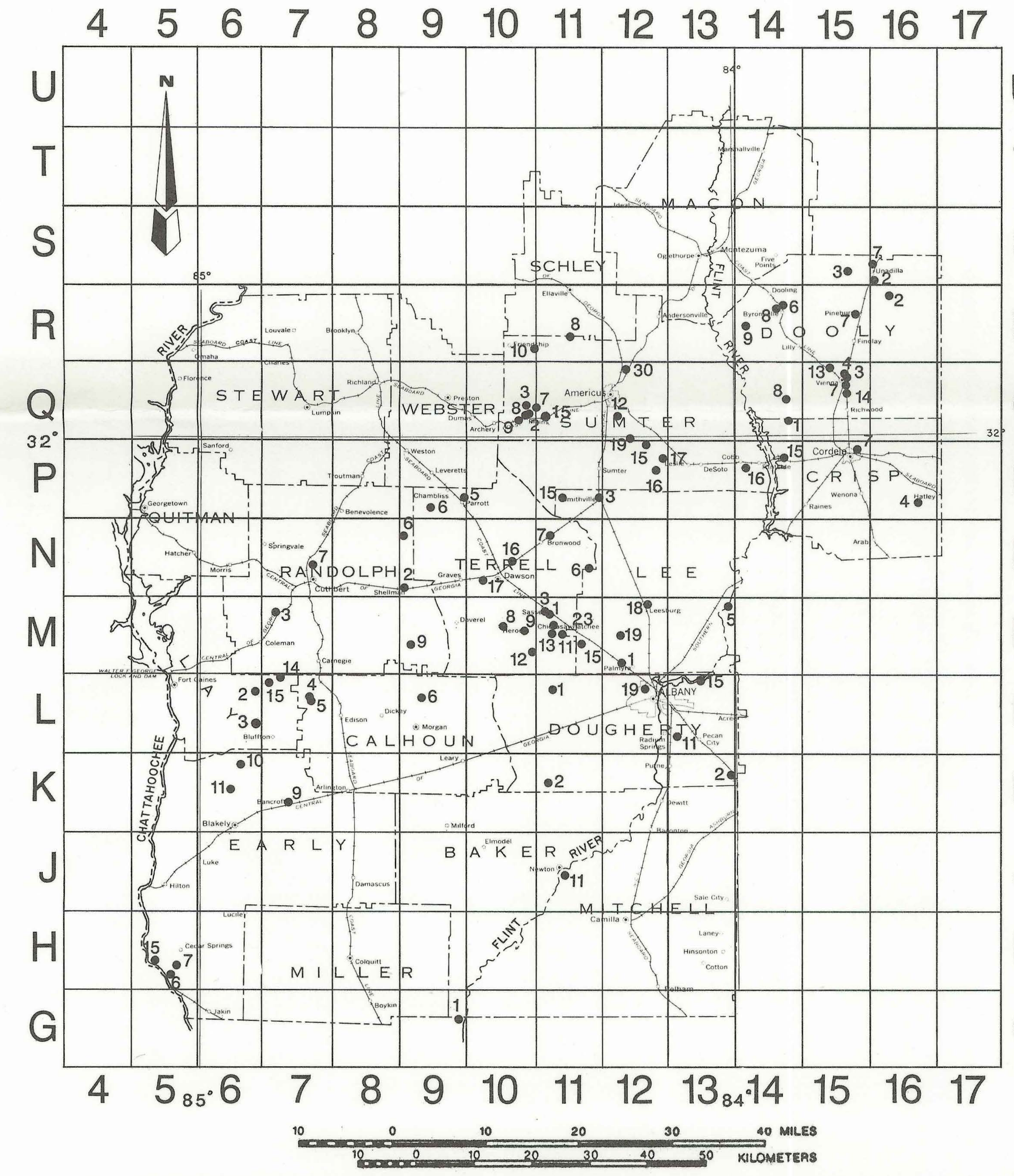
CLAYTON AND CLAIBORNE AQUIFERS - INDEX MAPS

CLAYTON AQUIFER



(U.S. Geological Survey Base Map, 1970)

CLAIBORNE AQUIFER



(U.S. Geological Survey Base Map, 1970)

INTRODUCTION

The purpose of this investigation is to update the hydrologic information available on the Clayton and Claiborne aquifers of southwest Georgia. This report is compiled from published and unpublished data from the Georgia Geologic Survey, other branches of the Georgia Environmental Protection Division, the U.S. Geological Survey, numerous municipalities, and conversations with water well drillers. It is intended to be an aid to ground-water users and administrators.

The following plates concerning water levels and water use were developed to describe and explain hydrologic trends occurring in the Clayton and Claiborne aquifers since 1981. Because water quality of confined aquifer systems usually changes very little with time, the water quality plates describe water quality without respect to time. This report does not include information on the hydrogeologic framework of the aquifers, other than the generalized stratigraphic column shown below. The column shows the general stratigraphy, lithology, and aquifer units in the Chattahoochee River Valley in southwest Georgia. The vertical line pattern from Oligocene to Miocene age on the chart indicates that sediments of these ages are not present in the Chattahoochee River Valley Area. Lithologic descriptions are generalized and do not detail facies changes within each formation or aquifer unit. Facies changes are discussed in later portions of the text when they affect aquifer parameters. Several references which describe portions of the study area are available and are listed in the publications. Descriptions of the two aquifers are given by McFadden and Perriello(1983). Clarke and others (1984) published an investigation of the Clayton aquifer of southwest Georgia.

INDEX MAPS AND TABLES

The Clayton and Claiborne aquifer base maps show the location of the water-level monitoring network established in each aquifer. These maps are accompanied below by tables correlating the well numbers with well owners, land surface elevations, and elevation of water levels in the fall of 1981, 1984, and 1986. The symbol 'N/A' on the tables indicates that a water-level measurement is not available for that year. Well construction information is listed in Georgia Geologic Survey Information Circular 55 (McFadden and Perriello, 1983) and in Georgia Geologic Survey files.

The wells have been numbered according to a system based on 7.5 minute topographic maps. The U.S. Geological Survey designated a number and letter to each 7.5 minute quadrangle in Georgia, based on its location. Wells located within each 7.5 minute quadrangle are numbered consecutively. To locate a well using the well number:

- locate the first digits of the well number along the numbered horizontal row of the grid map;
- follow the column vertically until it intersects the letter of the well number along the lettered vertical column of the grid map;
- use the last digits of the well number to find the well within the quadrangle.

CLAYTON AQUIFER WELLS - INDEX & WATER LEVELS (feet above mean sea level)

COUNTY	WELL #	WELL NAME	LAND SURFACE ELEVATION	1981	1984	1986
Calhoun	7L001	Calvin Eubanks #1	292	161.5	129.2	N/A
	7L003	H.T. McLendon #2	352	N/A	N/A	175.7
	7L011	H.T. McLendon #1	365	190.8	195.5	175.6
	8L001	Edison, Ga. 2	289	167.8	159.0	147.3
	9L001	Alvin Sudderth #3	281	138.7	143.0	110.0
	9L002	Wildmeade Plantation	211	137.2	136.1	140.2
	9L003	Adams-Curtiss & Bros. #2	260	141.0	140.6	98.0
	9L004	Morgan #1	242	N/A	171.3	125.2
	9L005	Morgan #2	240	154.6	N/A	126.3
	10L001	Adams-Curtiss & Bros. #2	226	133.6	130.1	105.3
	10L006	Graham Angus #2	232	134.7	135.8	97.3
Clay	5L001	W.F. George L & D (USGS recorder)	147	114.6	115.6	111.2
	5L005	Clay Co. School	395	124.7	N/A	112.8
	5M001	Giles Bros. #1	252	173.8	175.2	174.0
	5M004	E.E. Watson	275	242.1	243.9	242.8
	6L001	Bill Lindsey	390	201.9	200.5	193.5
	7L007	Bluffton #1	322	185.3	173.5	160.5
	7L012	Randall Richardson	395	198.8	194.9	184.9
Crisp	14P014	Vet. Mem. Park TW 1	252	N/A	213.5	203.9
Dooly	14Q004	J.E. Stewart	240	N/A	238.7	236.9
	14R001	J.D. Lester	385	N/A	300.5	298.7
	15R006	Grady Jones	365	N/A	334.3	325.3
Dougherty	11K005	USGS TW 12	183	148.5	141.9	133.7
	11L002	Albany Nursery	222	109.3	114.7	91.8
	11L005	Graham Angus #1	220	101.4	98.5	N/A
	12L020	USGS TW 6	198	49.5	43.5	39.9
	12L025	Swift & Co.	197	37.2	52.5	N/A
	13L002	Turner City	213	66.8	75.7	63.7
	13L013	USGS TW 7	195	80.9	83.0	N/A
Early	6K008	Blakely #2	250	142.7	131.3	141.6
	6K009	Kolomoki St. Pk. TW 1	310	161.8	156.9	156.9
	7K010	Singletary Farms Bancroft	232	155.0	144.0	127.7
	7K011	Singletary Farms Fairfield	230	139.1	126.2	111.4
Lee	11P014	Pete Long TW 1	338	N/A	182.2	176.9
	12M002	USGS TW 9	230	81.7	81.3	67.7
	12M008	Fowltown Plnt. #3	245	94.9	100.7	84.4
	12M009	Lee High Acres (Creekwood Apts.)	202	80.5	74.5	N/A
Mitchell	12K002	Baconton #3	172	N/A	146.0	114.3
Randolph	6M001	Coleman	415	N/A	232.5	231.5
	7N001	Cuthbert	455	305.9	N/A	301.8
	8M001	Bob Lovett	410	259.8	259.2	251.2
	8M002	James Grubbs & Sons #1	370	189.9	193.0	175.9
	8M003	James Grubbs & Sons #2	347	N/A	195.0	N/A
	8N001	James Peavay	463	288.7	289.4	279.6
	8N002	Melvin Peavy #1	435	255.0	251.5	229.1
	9M002	T.E. Allen Inc. 4	370	191.8	193.8	173.4
	9M004	Bruce Bynum	375	198.5	202.3	178.7
	9M007	C.T. Martin TW 2	322	173.8	174.4	152.3
Sumter	10P001	Gene Sutherland	445	374.0	376.5	376.4
	10Q007	Hugh Carter Worm Farm	480	378.8	382.6	380.1
	11P011	James Short #2	390	239.6	244.2	232.8
	11P012	Bert Thomas	432	215.9	221.3	206.3
	11Q003	Bowen	461	306.7	316.6	314.6
Terrell	9N001	Graves School	351	N/A	185.9	168.9
	9N005	Thomas Bentley	350	208.4	207.8	196.3
	9P002	City of Parrott #2	480	321.9	319.0	322.5
	10M002	Brown's Dairy	315	117.8	131.1	111.4
	10M005	Jimmy Bangs #2	298	140.1	132.4	N/A
	10M006	Bill Whitaker #2	268	112.5	103.4	N/A
	10M007	Bobby Locke	290	115.9	118.6	99.2
	10M009	John Daniels #3A	280	N/A	251.6	246.9
	10M011	Jimmy Bangs #3	298	174.9	176.6	161.3
	10N001	Dawson #3	350	N/A	129.5	127.1
	10N003	Steve Cocke Fish Hatchery #3	372	N/A	140.3	146.1
	10N005	Webb #1	348	131.8	145.6	117.3
	10N011	Dawson #4	330	124.6	119.6	117.3
	10N015	Vernon Copeland	365	123.8	135.8	113.8
	10N019	Dawson Maint. Bdg.	358	N/A	140.2	123.8
	10N020	Whitaker Lake House	340	N/A	133.4	N/A
	10P002	Don Foster	360	230.8	243.8	233.6
	11M002	Sasser #3	312	112.5	119.1	102.9
	11M004	Piedmont Plant Co.	270	105.4	105.2	89.3
	11N002	Bronwood #1	368	141.8	158.7	127.7
	11N003	Bronwood #2	355	N/A	144.0	116.8
	11N004	Ben Arthur	325	N/A	128.2	137.6
Webster	8P002	Raymond Goodman	530	385.9	385.7	383.9
	10P003	C.T. Black	400	N/A	N/A	343.1
	10R003	Winkler Farms	593	N/A	496.1	N/A

STRATIGRAPHIC COLUMN

(Generalized correlation of stratigraphic, lithologic and aquifer units in the Chattahoochee River Valley area, southwest Georgia)

ERATHEM	SYSTEM	SERIES	GROUP	FORMATION CHATTAHOOCHEE RIVER AREA	LITHOLOGY	AQUIFER OR CONFINING ZONE THIS REPORT	THICKNESS (feet)
CENOZOIC	QUATERNARY	HOLOCENE		Stream Alluvium and Undifferentiated Terrace Deposits	Silts, sands and clays.		
		PLEISTOCENE					
	TERTIARY	MIOCENE					
		OLIGOCENE					
		EOCENE		Ocala Limestone	Limestone, soft, porous, fossiliferous.[1]	Floridan aquifer.	0 - 200
			Claiborne Group	Lisbon Formation	Sand, fine, calcareous, fossiliferous, glauconitic; limestone; sandy limestone; and clayey sands.[1]	Lisbon confining unit.	0 - 70
				Tallahatta Formation	Sand, fine to coarse; gravelly at the base; grades upward into poorly sorted fine to coarse sand with highly fossiliferous limestone layers.[2]	Claiborne aquifer.	0 - 270
			Wilcox Group	Hatchetigbee Formation	Updip, interlaminated sequences of very fine sand, silt and clay.[2] Downdip, quartz sand, very fine to fine, little or no glauconite.[2] Basal Bashi Marl Member - sand, massively bedded, glauconitic, fossiliferous, calcareous.[1]	Wilcox confining zone. Sandy layers within this zone may yield sufficient quantities of water for domestic supply.	0 - 260
		PALEOCENE		Tuscahoma Sand	Basal quartz sand overlain by silt and clay, thinly bedded, laminated, carbonaceous, interbedded with fine quartzose sand.[1]		
				Nanafalia Formation	Sand and sandy clay, fine-grained, massively bedded, glauconitic.[1]		
			Midway Group	Clayton Formation (upper unit)	Silty sand, very-fine to medium, calcareous, contains thin beds of limestone and clay.[2]		
				Clayton Formation (middle unit)	Limestone, massive, recrystallized, highly fossiliferous, contains various percentages of sand.[2]	Clayton aquifer. Forms single aquifer unit with the upper member of the Providence Sand updip.	0 - 300
				Clayton Formation (lower unit)	Basal conglomerate overlain by sand and sandy marl, fine to coarse calcareous, locally arkosic, glauconitic and fossiliferous.[1,2]	Clayton-Providence confining zone. Where absent, the upper member of the Providence Sand and the Clayton Formation form a single aquifer unit.	0 - 130
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS (GULFIAN)		Providence Sand (upper unnamed sand member)	Sand; grades from a thickly bedded sand updip to a massive marine sand containing calcareous intervals downdip. In Albany, Dougherty County, upper part is a dense clayey sand. Middle part is a slightly dolomitic coquina grading upward to a siltstone. Lower part is sand containing varying amounts of silt.[3]	Providence aquifer. Forms a single aquifer unit with the Clayton Formation updip and Cusseta Sand and Ripley Formation downdip.	0 - 390
				Providence Sand (Perote Member)	Silt or very fine sand, highly micaceous, carbonaceous. East of Schley County, merges with upper member through facies change to coarse sand.[3]	Providence-Ripley confining zone. Where absent, the Providence Sand and upper part of Cusseta Sand form a single aquifer unit termed the Providence-Cusseta aquifer.	0 - 300
				Ripley Formation	Sand, fine, clayey, micaceous, fossiliferous; undergoes an eastward facies change to a clayey coarse sand between the Flint and Ocmulgee Rivers.[3]		
				Cusseta Sand	Sand, coarse, increasing amounts of thinly bedded carbonaceous clay toward the upper contact. Size and amount of sand decreases downdip where micaceous silt and clay dominate.[3]	Cusseta aquifer. Upper part forms a single aquifer unit with the Providence Sand and the Ripley Formation downdip and eastward.	0 - 150
				Blufftown Formation	Sand, fine, micaceous, calcareous, contains varying amounts of silt and clay.	Blufftown aquifer.	0 - 700
				Eutaw Formation	Alternating layers of sand, sandy clay and clay.		
				Tuscaloosa Formation			

(Modified from Clarke and others, 1983)

[1] McFadden and Perriello, 1983

[2] Clarke and others, 1984

[3] Clarke and others, 1983

CLAIBORNE AQUIFER WELLS - INDEX & WATER LEVELS (feet above mean sea level)

COUNTY	WELL #	WELL NAME	LAND SURFACE ELEVATION	1981	1984	1986
Calhoun	7L004	H.T McLendon #4	368	298.0	287.7	298.2
	7L005	McNair #2	352	299.0	296.6	296.4
	9L006	W.D. Beard #1	254	242.2	238.8	235.4
Clay	6L002	Isler Farm Flying Ser.	420	355.4	357.3	355.1
	6L003	Grady Milner	355	292.9	300.8	293.9
	7L015	Betty & Lee Boyette	405	359.3	361.0	359.1
Crisp	14P015	Vet Mem. Park TW2	252	N/A	N/A	230.4
	14Q001	John Biles	288	257.6	257.5	256.0
	15P007	Cordele #4	316	237.5	259.1	254.8
	16P004	Billy Green	392	N/A	246.2	N/A
Dooly	14Q008	Ed Cannon	310	264.5	265.0	262.1
	14R006	Byromville #2	358	N/A	279.4	272.2
	14R008	Byromville #1	380	N/A	275.8	274.1
	14R009	Dr. James Minor	325	275.1	272.2	266.4
	15Q003	Vienna #1	355	287.8	284.6	287.3
	15Q004	Vienna #2	355	287.9	285.5	285.8
	15Q007	Ga. Pacific Co. #3	340	N/A	300.2	283.8
	15Q013	Hardigree #2	341	305.5	310.0	301.5
	15Q014	B. Sanders	352	N/A	291.4	N/A
	15R007	Pinehurst - Horne TW	408	N/A	325.2	316.9
	15S003	Terrill Hudson	430	325.6	328.2	323.8
	16R002	William Sparrow	370	321.6	328.5	321.9
	16S002	Unadilla #3	376	312.1	316.0	307.5
	16S007	W.S. Stuckey	390	290.5	293.1	N/A
Dougherty	11K002	USGS TW 11	183	155.9	161.2	156.3
	11L001	USGS TW 4	220	193.7	196.3	185.5
	12L019	USGS TW 5	198	109.8	113.6	106.9
	13K002	Barlow, D.	246	171.03	181.4	N/A
	13L011	USGS TW 12	195	104.6	116.1	110.8
	13L015	Firewell - Sac Apron	200	95.5	118.66	102.9
Early	5H006	Georgia Tubing	111	N/A	71.4	53.0
	5H007	Great Southern Paper	160	N/A	91.0	95.8
	5H015	Great Southern Paper #2	114	N/A	75.1	73.0
	6K010	Kolomoki State Pk. TW 3	310	234.6	235.8	233.0
	6K011	P.A. Pitts Well B	315	N/A	259.1	N/A
	7K009	Singletary Farms	250	217.6	219.0	214.8
Lee	11M015	W.H. Fryer	258	211.7	212.3	200.9
	11P003	Smithville #2	320	280.6	282.4	280.7
	11P015	Pete Long TW 2	338	298.8	302.2	298.5
	12M001	USGS TW 8	235	128.3	133.7	114.6
	12M018	Lessburg #2	261	215.3	217.9	N/A
	12M019	Haley Bros. Farm	220	162.8	165.1	N/A
Mitchell	11J011	USGS TW DP 10	165	N/A	128.9	121.7
Randolph	7L014	Marcus Regans	360	313.5	315.9	314.1
	7M003	Walter (Bubba) Stanley	470	425.7	429.2	427.0
	7N007	Gene Kennedy	474	433.7	435.2	434.0
	9M009	C.T. Martin TW 1	322	291.4	294.2	291.9
	9N002	Shellman	393	361.5	353.5	345.5
	9N006	Dean Whaley #1	470	402.3	406.2	404.4
Sumter	10Q002	Plains #3	494	460.1	460.7	460.3
	10Q003	D. Murray	509	457.7	457.9	457.2
	10Q008	Plains #4	492	459.9	460.8	459.5
	10Q009	Gloria Spann	503	458.5	460.2	458.8
	11Q007	SWGA Exp. Sta. #1	510	452.6	454.3	449.4
	11Q015	SWGA Exp. Sta. #2	505	450.8	453.2	451.3
	11R008	R.S. Moore	512	442.5	445.8	445.5
	11R010	Harold Darden	530	451.4	454.7	449.6
	12P015	Henry Hart #1A	343	306.1	313.0	305.9
	12P016	Henry Hart 2A	348	294.5	305.5	293.2
	12P017	Boots Lyles	365	294.6	304.0	295.1
	12Q012	Comere (F. Waitman)	373	319.4	322.3	320.5
	12Q019	Powell Farms	357	N/A	314.4	309.9
	12Q030	Clarke Rainbow Center	461	415.6	421.00	415.9
	14P016	Charles Miller #2	285	245.6	243.1	243.7
Terrell	9P005	Jack Ballentine	450	409.4	414.3	412.3
	9P006	Margaret Brunner	375	N/A	N/A	306.9
	10M008	Sonny Reese	270	260.6	262.7	261.0
	10M009	John Daniels #3B	280	N/A	247.5	246.9
	10M012	Tallasee	245	N/A	239.7	205.7
	10N016	Sheriff Jerry Dean	340	313.7	316.0	314.2
	10N017	Bob Chambliss	371	332.1	329.8	335.3
	11M001	Sasser #1	314	267.1	272.7	264.3
	11M003	Sasser #2	314	265.8	269.9	263.4
	11M011	John Daniels #2	290	236.0	238.2	229.5
	11M013	John Daniels #1	309	N/A	274.0	246.0
	11M023	John Daniels #1A	309	256.2	263.3	258.4
	11N006	Betty & John Wise	301	257.4	260.3	257.1
	11N007	John Willis	362	309.4	308.5	309.5
Worth	13M005	USGS TW DP 7	238	N/A	227.4	218.4

Hydrogeology and Compilation
by
Anna F. Long
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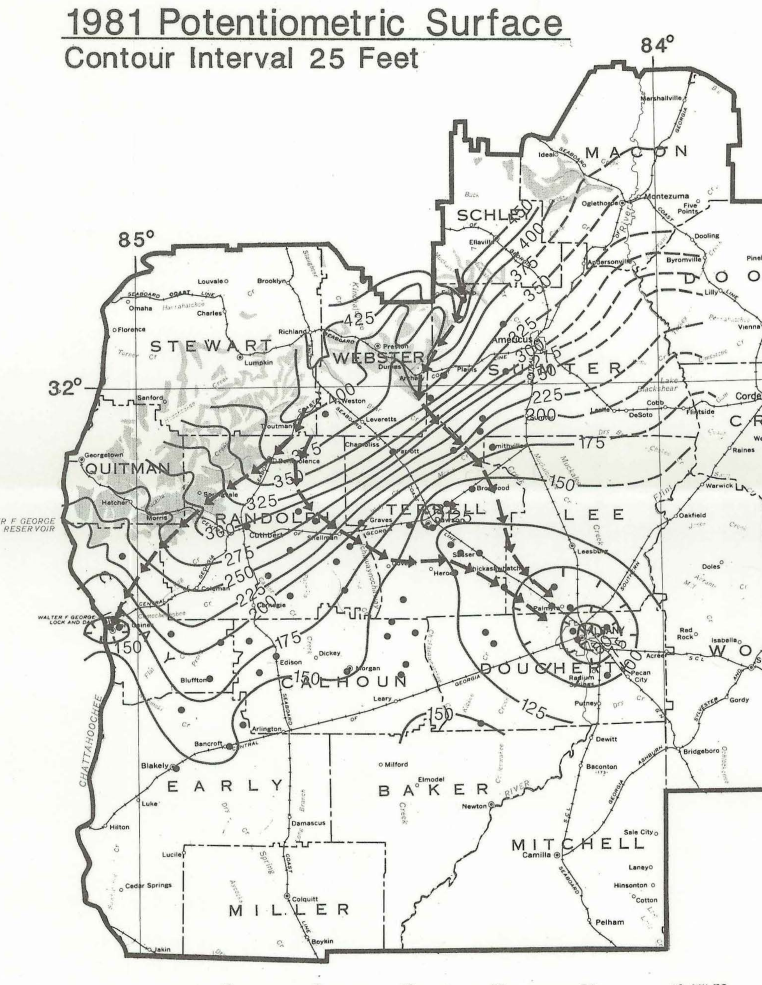
POTENTIOMETRIC SURFACE TRENDS - CLAYTON AQUIFER

1981 Potentiometric Surface

Contour Interval 25 Feet



(McFadden and Perriello, 1983)

EXPLANATION

—100— Potentiometric surface contour in feet above mean sea level. Dashed where approximated. Arrows indicate ground-water flow direction.

• Well location.

Outcrop area of Paleocene Undifferentiated Sediments.

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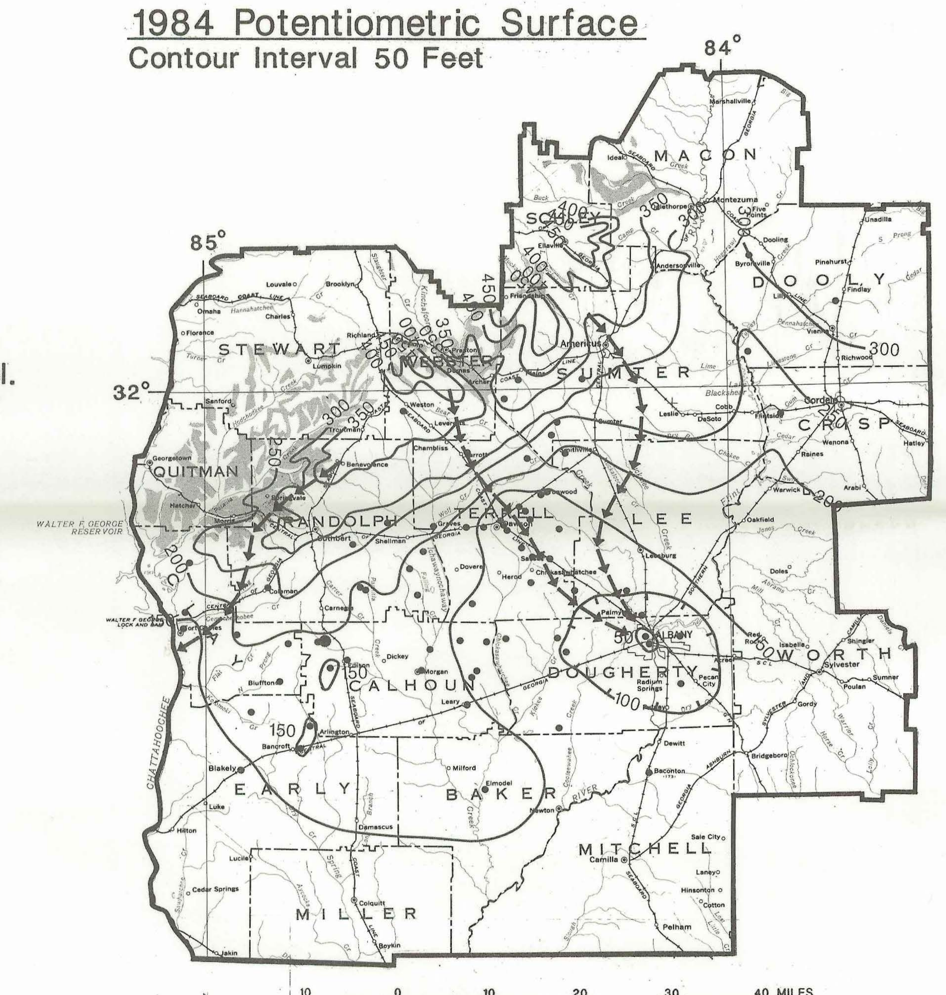
1984 Potentiometric Surface

Contour Interval 50 Feet



(Clarke and others, 1985)

Hydrogeology and Compilation
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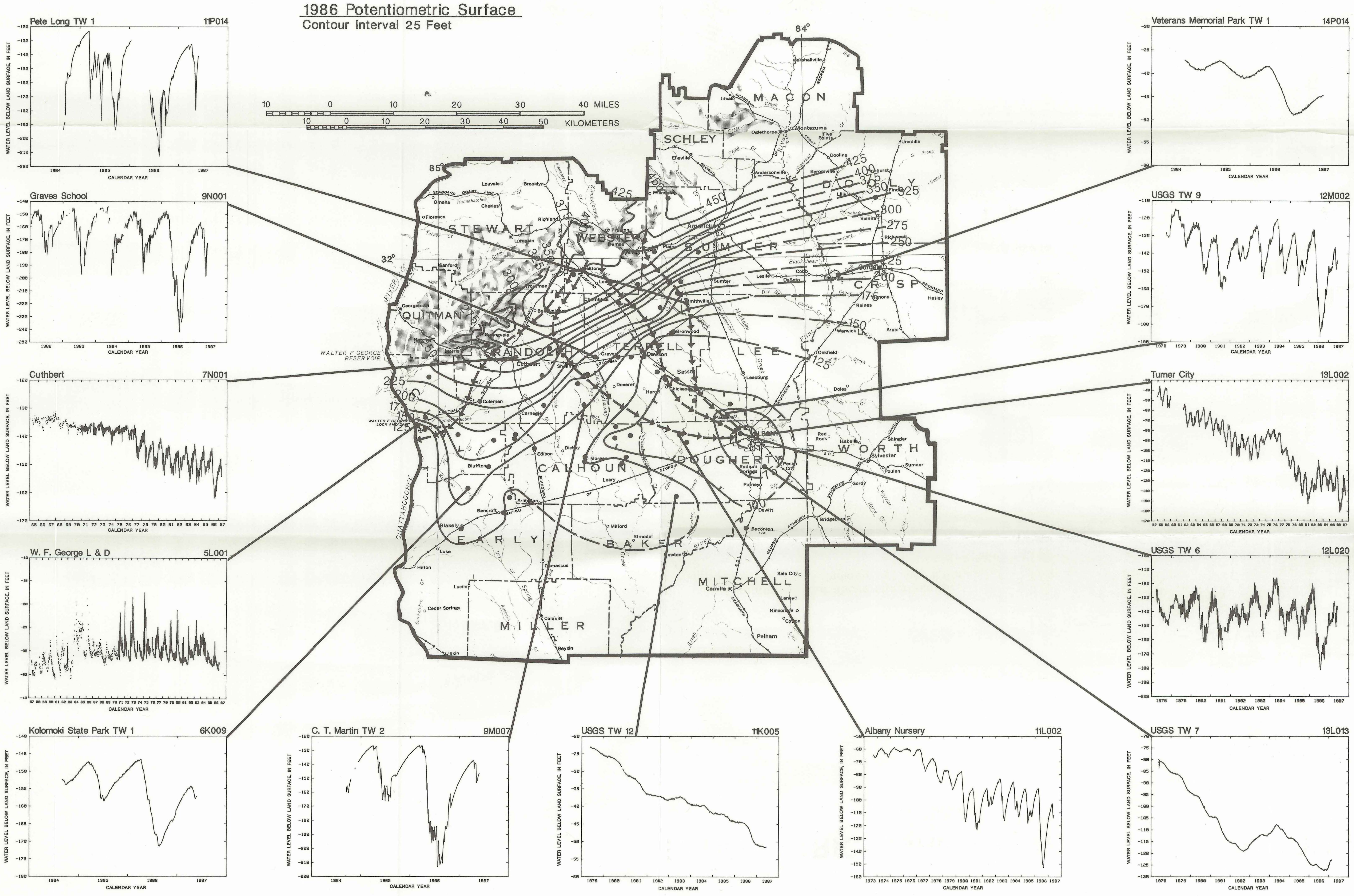
1986 Potentiometric Surface

Contour Interval 25 Feet



Water levels in the Clayton aquifer are affected by seasonal variations in withdrawals and precipitation. Clayton aquifer water levels tend to rise in winter months when precipitation is high and consistent and evapotranspiration and withdrawal rates are low. Water levels decline in summer months when withdrawal and evapotranspiration rates increase. Areas affected by large withdrawals include the Albany area and the agricultural areas in Calhoun, Randolph, and Terrell Counties.

Ground-water hydrographs record changes in daily mean water levels over time. Vertical and horizontal hydrograph scales differ depending on period of record and degree of water-level fluctuation. Hydrographs with longer periods of record show long-term aquifer trends but do not depict seasonal variations because of the condensed horizontal scale. The hydrographs on this plate were produced by the U.S. Geological Survey (USGS), and show daily mean water levels in 13 Clayton aquifer wells.

Water-level fluctuations shown on hydrographs from wells 12M002, 12L020, 13L002, and 7N001 are caused by seasonal variations in municipal withdrawals. The hydrograph from well 13L002 also illustrates the long-term declining water-level trend in the Clayton aquifer. The water level in this well dropped approximately 90 feet between the late 1950's and 1986. Agricultural withdrawals affect water levels in the Clayton aquifer as seen on hydrographs from wells 11L002, 9M007, 9N001, and 11P014. Well 9M007 is approximately 150 feet from an irrigation well developed in the Clayton aquifer. The tightly spaced series of increases and decreases on the hydrograph for well 9M007 probably coincide with specific periods of irrigation. Wells 13L013 and 11K005 are located in a low permeability area of the Clayton aquifer. Hydrographs from these wells show little annual water level fluctuations but illustrate overall water level declines.

Water levels were measured between October 27 and November 5, 1986, in a network of 67 wells developed only in the Clayton aquifer. These measurements were plotted and contoured to form the 1986 potentiometric surface map of the Clayton aquifer. A potentiometric surface map illustrates the imaginary surface to which water in tightly cased wells would rise due to potential energy in confined aquifers. Potentiometric surface maps can be used to delineate general recharge and discharge areas and ground-water flow directions.

The shaded regions on the potentiometric surface maps correspond to the outcrop area of Paleocene undifferentiated sediments, of which the Clayton aquifer is a part. The northwestern part of the outcrop area is not contoured because it is not contiguous with the Clayton aquifer. Primary recharge to the aquifer is by rainfall infiltrating the outcrop. The Clayton aquifer discharges to streams in which it crops out, except when the river stage exceeds the water level in the aquifer. The Clayton aquifer also supplies a large number of wells in southwest Georgia.

Ground water flows from areas of high to low hydraulic potential. Flow lines have been drawn on the potentiometric surface maps. The dominant ground-water flow direction in the Clayton aquifer is from the recharge area southeast towards Albany. Ground water also flows from the recharge area southwest towards the Chattahoochee River. A ground-water divide exists between the Chattahoochee and Flint Rivers.

For consistency, the following comparison of potentiometric surfaces for the years 1981, 1984, and 1986 considers the isopotential level of water in the aquifer during the late fall-early winter. This seasonal view illustrates more clearly the combined effects of drought conditions and increased pumpage on the aquifer. Note that the 1981 and 1986 maps have contour intervals of 25 feet. The 1984 map has a contour interval of 50 feet.

The cone of depression, centered around Albany, has been increasing in areal and vertical extent since the 1950's. The effect of the 1981 drought is illustrated on the 1981 potentiometric surface map by the extension of the 125 foot contour line into Terrell County, a few miles southeast of Dawson. The deepest water level in November, 1981 was recorded in well 12L025 (Swift and Co.) in the center of the cone of depression at Albany. The water level was 159.8 feet below land surface (or at an elevation of 37.2 feet above mean sea level).

During 1982 and 1983, above normal precipitation and the corresponding decrease in withdrawals allowed water levels in the Clayton aquifer to recover as much as 11 feet (Clarke and others, 1985). During 1984, water levels were lowered by a mean annual average of 2.5 feet as a result of below-normal precipitation (Clarke and others, 1985). The 1984 potentiometric surface was generally higher than the 1981 potentiometric surface except in some local areas where extensive seasonal withdrawals occurred.

The fall of 1986 followed another summer of severe drought in Georgia. As a result, ground-water withdrawals from the Clayton aquifer increased. The most dramatic change in the potentiometric surface of the Clayton aquifer, between 1984 and 1986, is the shape and extent of the cone of depression around Albany. The 100 foot contour extended as far northwest as Sasser (Terrell County) in 1986. In 1984, the 100 foot contour barely extended into Terrell County. In addition, a westward trending arm developed in the 100 foot contour of the cone and extended approximately five miles into Calhoun County. The water level in well 12L020 (USGS TW 6, located near the center of the cone) was approximately 10 feet lower in 1986 than it was in 1981.

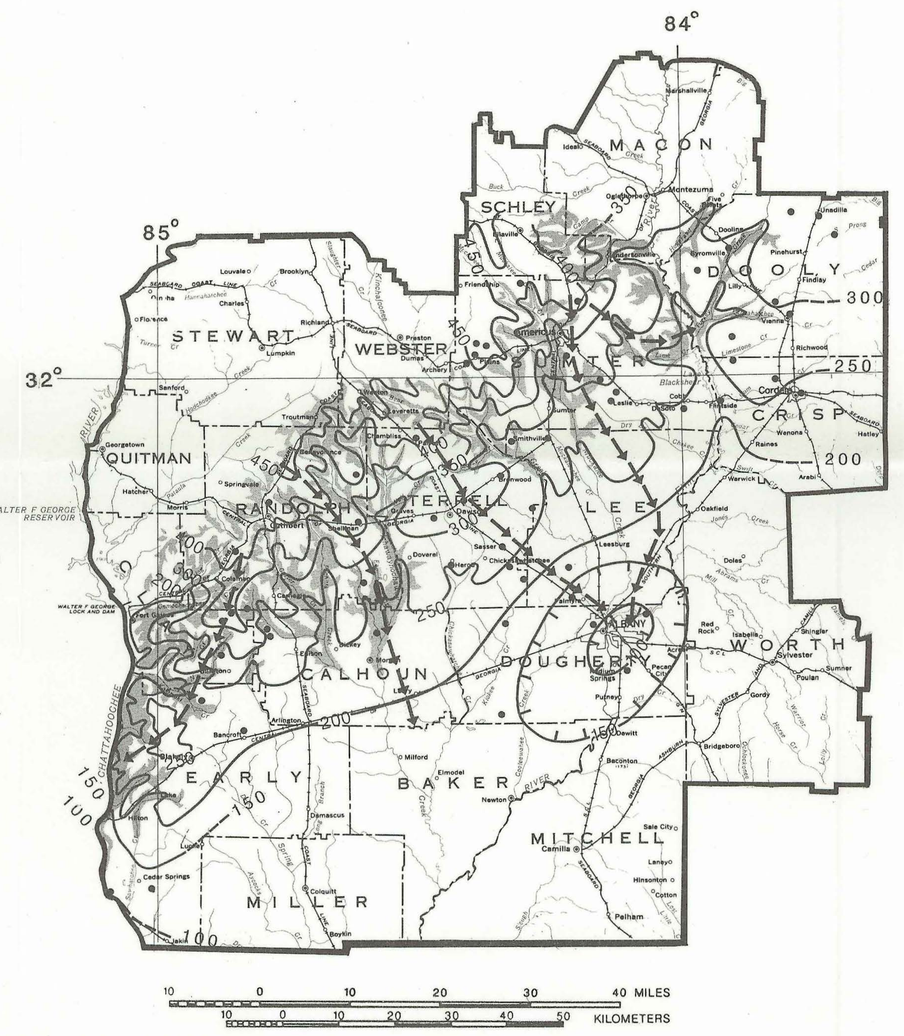
In the western part of the study area, along the Chattahoochee River, water levels in the Clayton aquifer reflect river and reservoir stage variations but show little long-term trend. The lack of water-level declines is due to the interconnection of the Chattahoochee River, the Walter F. George Reservoir, and the Clayton aquifer. The direct interaction between the Clayton aquifer and the reservoir was illustrated by Clarke and others (1984). The water level in well 5L001 (USGS recorder well at the Walter F. George Lock and Dam) showed a comparatively small decline of 3.4 feet since 1981. Contours bending around the Walter F. George Lock and Dam and the Fort Gaines area, in addition to the interconnection of the aquifer and reservoir described by Clarke and others (1985), indicate aquifer discharge to the Chattahoochee River. Further east in Clay County, withdrawals have a greater effect on the potentiometric surface of the Clayton aquifer.

The Clayton aquifer potentiometric surface appears to decline seasonally, but recover annually, in the northern part of the study area. The steeper potentiometric surface in this area probably is a result of local topography. It may also be caused in part by decreased aquifer transmissivity coupled with heavy withdrawals downgradient. Water level decreases in this area probably are indicative of decreased precipitation and/or increased local pumping.

The depressed equipotential contours of the fall 1986 potentiometric surface map illustrate the increased stress placed on the Clayton aquifer. The declines are attributed to limited recharge (due to low permeable outcrop sediments,and a relatively small outcrop area with steep slopes), reduced recharge during drought years, and increased agricultural and municipal withdrawals. Although the cone of depression is centered around Albany, water-level declines are occurring at more rapid rates in the agricultural areas of Calhoun, Randolph, and Terrell Counties. Continued declines in water levels in the Clayton aquifer are a major concern of ground-water users in southwest Georgia.

POTENTIOMETRIC SURFACE TRENDS - CLAIBORNE AQUIFER

1981 Potentiometric Surface
Contour Interval 50 Feet



(McFadden and Perriello, 1983)

EXPLANATION

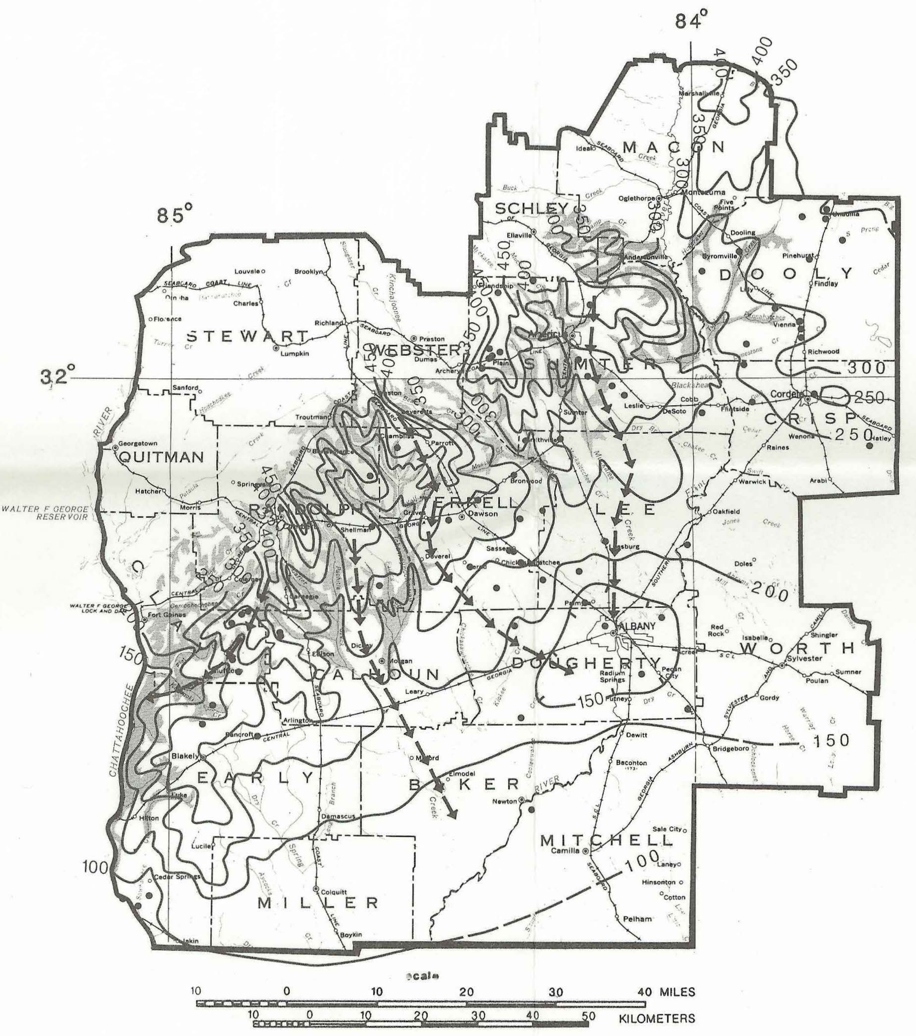
100 — Potentiometric surface contour in feet above mean sea level. Dashed where approximated. Arrows indicate ground-water flow direction.

• Well location.

▢ Outcrop area of Claiborne Undifferentiated Sediments, Tallahatta Formation and Lisbon Formation.

N

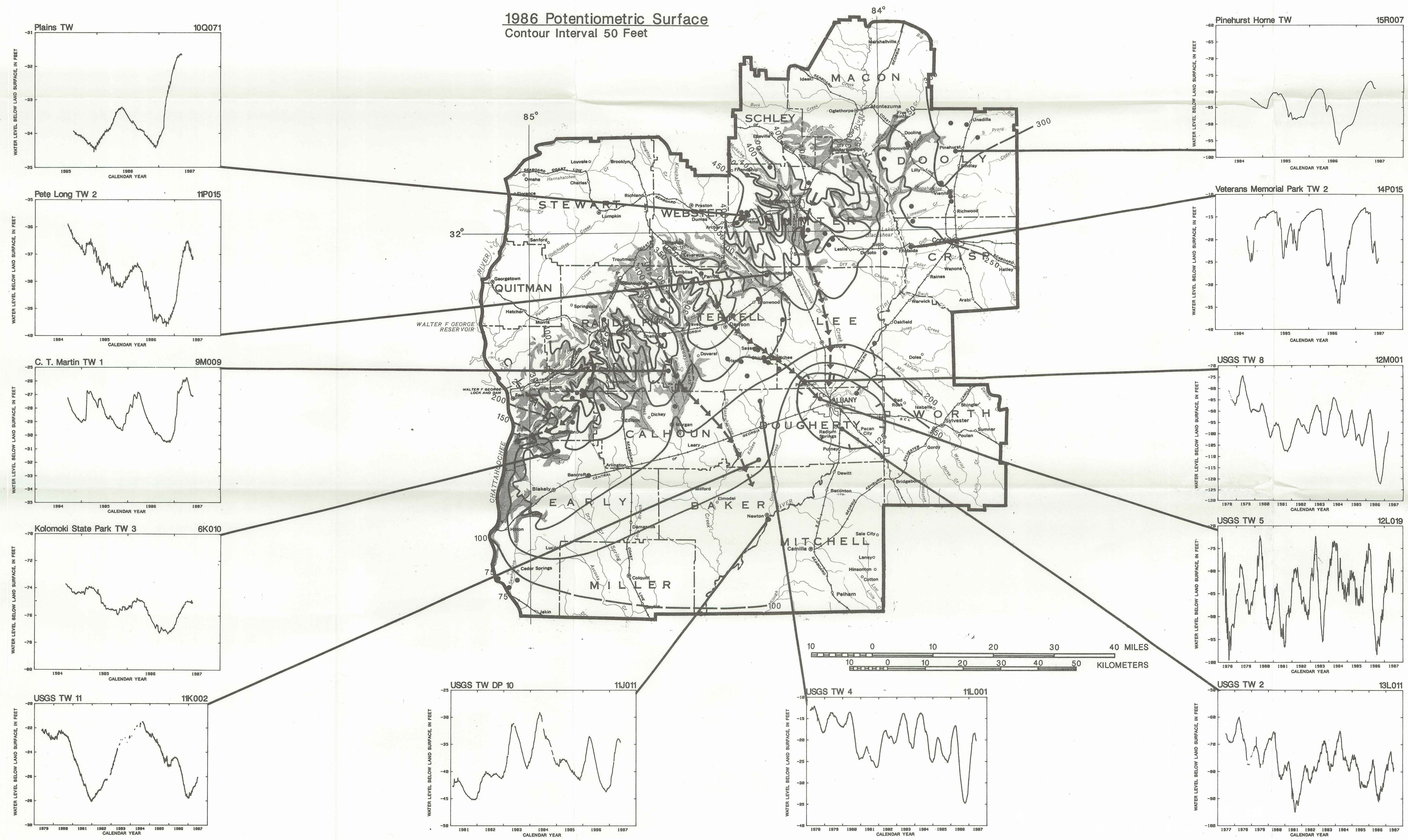
1984 Potentiometric Surface
Contour Interval 50 Feet



(Clarke and others, 1985)

Hydrogeology and Compilation
by
Anna F. Long
1989

1986 Potentiometric Surface
Contour Interval 50 Feet



Seasonal recharge and discharge variations affect Claiborne aquifer water levels. Water levels generally are lowest in the summer, when precipitation is low and withdrawal and evapotranspiration rates are high. Claiborne aquifer water levels rise in winter months, when withdrawal and evapotranspiration rates decrease and precipitation is relatively high and consistent.

Water-level measurements plotted as hydrographs by the U.S. Geological Survey (USGS) show mean daily water levels in 12 wells throughout the study area. The hydrographs illustrate annual and seasonal water-level fluctuations. All Claiborne hydrographs show significantly lower water levels during 1986, coinciding with the drought.

Hydrographs from wells located near the Claiborne aquifer recharge area, 10Q071, 9M009, 11P015, 6K010, and east of the Flint River 15R007 and 14P015, show water levels which have fully recovered from the 1986 drought. The water-level recovery in these wells is attributable to the close proximity of the recharge area.

Water levels depicted on hydrographs from wells located southeast and downdip of the recharge area do not appear to recover as quickly as the previously referenced wells. The slower recovery rate is a result of continuing local pumping combined with greater distance from the outcrop area. The water level in well 12L019 dropped to a low of 98 feet below land surface in 1986. The water level recovered 13 feet by the end of 1986, and continued to rise to near pre-drought levels in 1987.

Water levels were measured between October 27 and November 5, 1986 in 72 wells developed only in the Claiborne aquifer. These measurements were plotted and contoured to produce the fall 1986 potentiometric surface map of the Claiborne aquifer. The 1981, 1984, and 1986 potentiometric surface maps display the isopotential level of water in the Claiborne aquifer during the fall of each year.

The main recharge mechanism to the Claiborne aquifer is rainfall infiltrating the outcrop. The numerous convoluted contours in the outcrop area indicate a significant degree of stream-aquifer interaction. The Claiborne aquifer discharges directly to many streams in this area. The Claiborne aquifer supplies large quantities of water to wells for public, agricultural, industrial, and domestic use in the study area.

Ground-water flow lines have been drawn perpendicular to equipotential lines on the potentiometric surface maps. The dominant ground-water flow direction in the Claiborne aquifer is from the recharge area southward towards Albany. A significant amount of ground water flows from the recharge area southwest towards the Chattahoochee River.

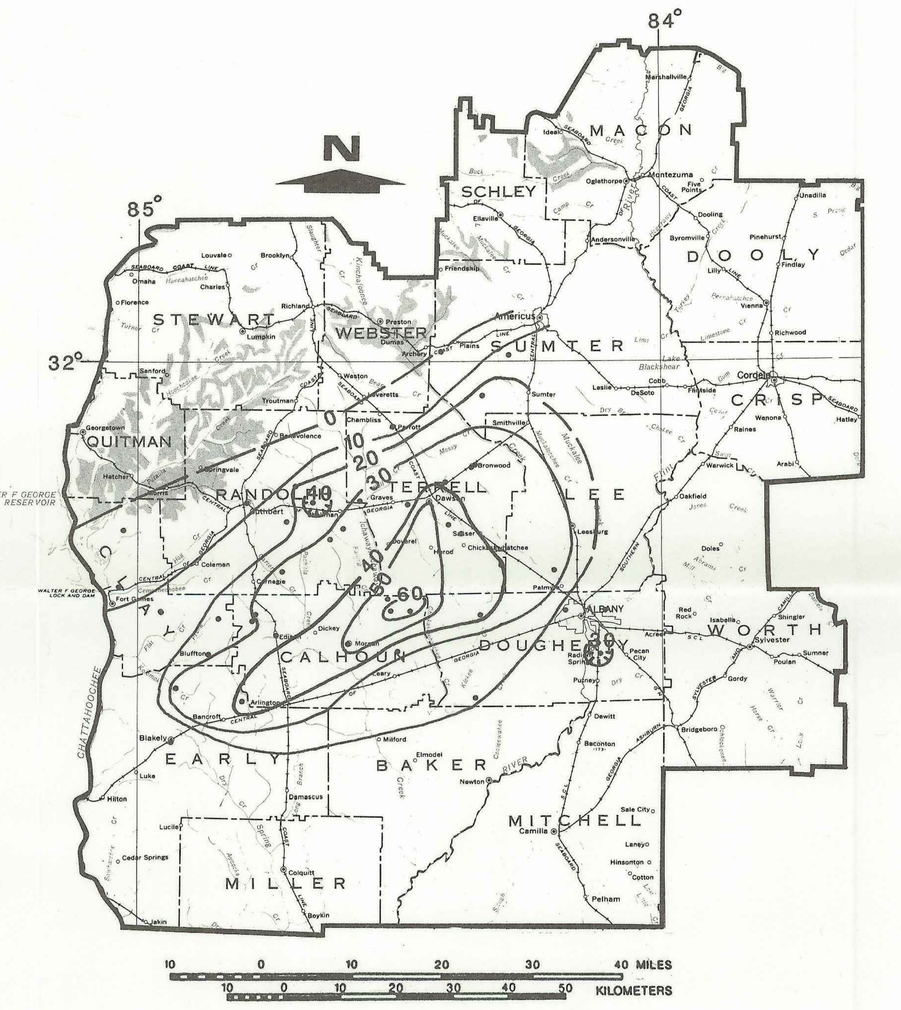
The potentiometric surface of the Claiborne aquifer is stable relative to the Clayton aquifer potentiometric surface. A long-term trend of water-level decline is apparent in the Claiborne aquifer but is less pronounced than the decline in the Clayton aquifer. The Claiborne aquifer potentiometric surface is affected by rainfall regionally and concentrated pumping locally. The configuration of the cone of depression centered around Albany appears to change orientation over time. These dissimilarites are probably caused by the various contouring interpretations of different authors. The areal extent of the cone has not expanded significantly since 1981. The greatest water level decline in the cone since 1981, 8.2 feet, was recorded in well 11L001 (USGS TW 4). The greatest water level decline between the fall of 1984 and 1986 in the center of the cone of depression was 19.1 feet and occurred in well 12M001 in southern Lee County.

The Claiborne aquifer is stressed locally by municipal and irrigation withdrawals. These stresses do not produce large enough declines in water levels to be apparent on regional potentiometric surface maps. Some specific wells had noticeable declines in water level between 1984 and 1986. Well 16S002 (see Plate 1) in Dooly County had a decline of 8.5 feet. The Shellman municipal well (9N002, see Plate 1) in Randolph County showed a decrease of 8.0 feet since 1984. Wells used for irrigation also had significant declines between the fall of 1984 and 1986. Some of these include wells 12P015, 12P016, in Sumter County 10M012, in Terrell County (see Plate 1) which showed water level declines of 7.1, 12.3, and 34.0 feet, respectively.

Overall, the Claiborne aquifer water levels tend to recover after being stressed by summer pumpage. Recovery time appears to be a function of pumping duration and withdrawal rate as well as distance from recharge areas. Although the 1986 potentiometric surface is depressed relative to the 1984 surface, water levels show significant recovery.

GROUND-WATER WITHDRAWAL DATA - CLAYTON AND CLAIBORNE AQUIFERS

FIGURE 1 – Clayton aquifer: Change in hydraulic potential map, 1979–1986.



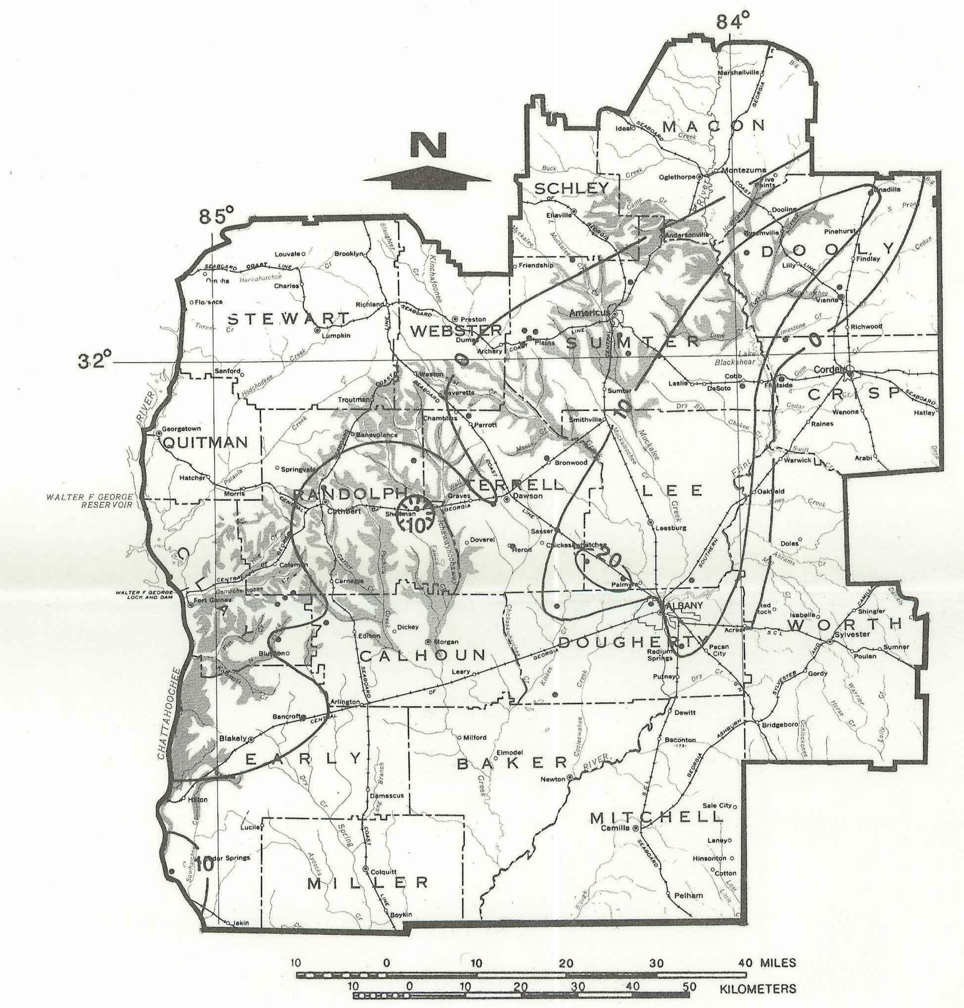
EXPLANATION

——10—— Decrease in water level, contour in feet.

• Well location.

▢ Outcrop area.

FIGURE 2 – Claiborne aquifer: Change in hydraulic potential map, 1979–1986.



EXPLANATION

——10—— Decrease in water level, contour in feet.

• Well location.

▢ Outcrop area.

TABLE 1

CLAYTON AQUIFER PUBLIC SUPPLY & INDUSTRIAL GROUND-WATER WITHDRAWAL ESTIMATES

COUNTY	USER NAME	USE	1982	1983	1984	1985	1986	COMMENTS
			Annual Average Ground-Water Withdrawal (MGD)					
Calhoun	Edison	M	0.197	0.169	0.160	0.171	0.185	a
	Leary	M	0.020	0.019	0.017	0.020	0.021	a, M1
	Arlington	M	0.286	0.299	0.357	0.280	0.306	a
	Morgan	M	0.060	0.060	0.060	0.060	0.060	b
Clay	Bluffton	M	0.022	0.022	0.022	0.022	0.022	b
Dougherty	Albany	M	5.807	5.702	5.793	5.499	6.240	a, M2
	Miller Brewery	I	0.078	0.062	0.055	0.058	0.055	a, M3
Early	Blakely	M	1.039	1.027	1.149	1.216	0.790	a
Lee	Lee High W.S.	S	0.064	0.064	0.064	0.064	0.064	b
	Glendale Subdivision	S	0.011	0.011	0.011	0.011	0.011	d
Mitchell	Baconton	M	0.046	0.046	0.046	0.046	0.046	b
Randolph	Coleman	M	0.009	0.009	0.009	0.009	0.009	b
	Cuthbert	M	0.415	0.415	0.415	0.415	0.415	b
Sumter	Correctional Inst.	G	0.010	0.010	0.010	0.010	0.010	d
	Triple T Trailer Pk.	T	0.002	0.002	0.002	0.002	0.002	d
	Koinoina Partners	S	0.002	0.002	0.002	0.002	0.002	d
Terrell	Dawson	M	0.930	1.023	1.005	1.130	1.681	a
	Sasser	M	0.075	0.075	0.075	0.075	0.075	b
	Parrott	M	0.021	0.021	0.021	0.021	0.021	b
	Bronwood	M	0.113	0.113	0.113	0.113	0.113	b
	Steve Cocke Fish	I	0.308	0.308	0.308	0.308	0.308	b
	Lee MHP	T	0.005	0.005	0.005	0.005	0.005	d
TOTALS			9.520	9.464	9.699	9.537	10.441	

ABBREVIATIONS

M - Municipal
I - Industrial
T - Trailer Park
S - Subdivision
G - Government Institution
a - Value from water-use report forms
b - Value estimated by city utilities superintendent or mayor
c - Permitted value of withdraw
d - Value based on population multiplied by 75 gallons per day per person
M1 - Multiaquifer well: 43% Clayton, 57% Claiborne
M2 - Multiaquifer well: from 1982-1984; 35% Clayton, 59% Claiborne, 6% Providence
from 1984-1986; 32% Clayton, 59% Claiborne, 6% Providence
3% Floridan
M3 - Multiaquifer well: 5% Clayton, 94% Claiborne, 1% Providence

TABLE 2

CLAIBORNE AQUIFER PUBLIC SUPPLY & INDUSTRIAL GROUND-WATER WITHDRAWAL ESTIMATES

COUNTY	USER NAME	USE	1982	1983	1984	1985	1986	COMMENTS
			Annual Average Ground-Water Withdrawal (MGD)					
Calhoun	Leary	M	0.026	0.025	0.023	0.026	0.028	a, M1
Crisp	Cordele	M	0.923	0.936	-	1.184	1.256	a, M2
Dooly	Unadilla	M	-	-	-	0.032	0.031	a
	Vienna	M	0.346	0.434	0.551	0.549	0.433	a
	Ga. Pacific Corp.	I	0.130	0.130	0.130	0.130	0.130	b
	Pinehurst	M	0.60	0.060	0.060	0.060	0.060	b
	Lilly	M	0.012	0.012	0.012	0.012	0.012	b
	Byromville	M	0.046	0.046	0.046	0.046	0.046	b
Dougherty	Albany	M	9.862	9.683	9.837	10.139	11.504	a, M3
	Miller Brewery	I	1.461	1.172	1.042	1.097	1.032	a, M4
	Marine Corps	M	0.954	0.968	1.008	0.976	0.997	a, M5
Early	Great Southern Paper Co.	I	0.055	0.959	0.130	0.140	0.523	a
Lee	Leesburg	M	0.180	0.180	0.180	0.180	0.180	c
	Smithville	M	0.065	0.065	0.065	0.065	0.065	d
Randolph	Shellman	M	0.230	0.023	0.023	0.023	0.023	b
Sumter	Plains	M	-	0.111	0.136	0.160	0.168	a
	DeSoto	M	0.019	0.019	0.019	0.019	0.019	b
	Leslie	M	0.904	0.904	0.904	0.904	0.904	b
Terrell	Lazy Pines MHP	T	0.003	0.003	0.003	0.003	0.003	d
TOTALS			15.276	15.937	14.376	15.952	17.621	

ABBREVIATIONS

M - Municipal
I - Industrial
T - Trailer Park
a - Value from water-use report forms
b - Value estimated by city utilities superintendent or mayor
c - Permitted value of withdraw
d - Value based on population multiplied by 75 gallons per day per person
M1 - Multiaquifer well: 43% Clayton, 57% Claiborne
M2 - Multiaquifer well: 65% Claiborne, 35% Floridan
M3 - Multiaquifer well: from 1982-1984; 35% Clayton, 59% Claiborne, 6% Providence
from 1984-1986; 32% Clayton, 59% Claiborne, 6% Providence
3% Floridan
M4 - Multiaquifer well: 5% Clayton, 94% Claiborne, 1% Providence
M5 - Multiaquifer well: 80% Claiborne, 10% Floridan, 10% Wilcox

TABLE 3

SELF-SUPPLIED GROUND-WATER WITHDRAWAL ESTIMATES - 1985 -

County	Floridan %	Floridan MGD	Claiborne %	Claiborne MGD	Clayton %	Clayton MGD	Cretaceous %	Cretaceous MGD	Total MGD
Baker	100%	.210	—	—	—	—	—	—	.210
Calhoun	50%	.039	35%	.027	.15%	.012	—	—	.078
Clay	—	—	65%	.074	15%	.017	20%	.023	.114
Crisp	100%	.595	—	—	—	—	—	—	.595
Dooly	90%	.275	10%	.031	—	—	—	—	.306
Dougherty	100%	.119	—	—	—	—	—	—	.119
Early	65%	.315	35%	.170	—	—	—	—	.485
Lee	80%	.533	15%	.100	5%	.033	—	—	.666
Macon	—	—	—	—	—	—	100%	.428	.428
Miller	100%	.362	—	—	—	—	—	—	.362
Mitchell	100%	.771	—	—	—	—	—	—	.771
Quitman	—	—	—	—	—	—	100%	.101	.101
Randolph	—	—	65%	.147	35%	.079	—	—	.226
Schley	—	—	30%	.039	—	—	70%	.090	.129
Stewart	—	—	—	—	—	—	100%	.169	.169
Sumter	—	—	85%	.715	5%	.042	10%	.084	.841
Terrell	—	—	100%	.353	—	—	—	—	.353
Webster	—	—	20%	.021	30%	.032	50%	.053	.106
Worth	100%	.767	—	—	—	—	—	—	.767
TOTALS:		3.986		1.677		0.215		0.948	6.826

TABLE 4

IRRIGATION GROUND—WATER WITHDRAWAL ESTIMATES

COUNTY	CLAIBORNE MGD 1981	CLAIBORNE MGD 1984	CLAIBORNE MGD 1986	CLAYTON MGD 1981	CLAYTON MGD 1984	CLAYTON MGD 1986
Baker	—	—	—	—	—	—
Calhoun	1.92	3.39	4.15	0.68	1.20	1.47
Clay	0.36	0.23	0.45	1.11	0.70	1.37
Crisp	1.39	0.63	2.80	—	—	—
Dooly	7.05	5.87	9.13	0.53	0.44	0.69
Dougherty	—	—	—	0.38	0.38	0.60
Early	4.67	5.36	9.10	0.17	0.19	0.32
Lee	16.63	6.42	9.10	2.05	0.79	1.12
Macon	—	—	—	—	—	—
Miller	—	—	—	—	—	—
Mitchell	—	—	—	—	—	—
Quitman	—	—	—	—	—	—
Randolph	0.53	0.26	0.40	6.36	3.09	4.71
Schley	—	—	—	—	—	—
Stewart	—	—	—	—	—	—
Sumter	12.92	4.59	9.92	6.57	2.33	5.04
Terrell	1.30	0.43	1.11	7.34	2.41	6.31
Webster	—	—	—	—	—	—
Worth	0.49	0.23	0.51	—	—	—
TOTALS	47.26	27.41	46.67	25.19	11.53	21.63

The Clayton and Claiborne aquifers are major sources of ground water for public supply, industrial, self-supplied, and agricultural users in southwest Georgia. In this report, public supply refers to facilities which sell water to users such as municipalities, subdivisions, and trailer parks. Declining water levels in these aquifers, especially the Clayton, have prompted this investigation. In order to perform water budget analyses on these aquifers, accurate recharge and discharge rates are required. Data needed to evaluate recharge and discharge to and from the aquifers are not available. Therefore, these parameters have been estimated. The following paragraphs describe the methods used to estimate public supply, industrial, self-supplied, and agricultural ground-water withdrawals. These numbers are, in fact, estimates and, at best, provide relative usage figures for each aquifer.

The major source of recharge to both of the aquifers is rainfall infiltrating the outcrop areas. The recharge area of the Clayton aquifer has been estimated to be 70 to 80 square miles; while the Claiborne aquifer recharge area covers approximately 350 square miles (McFadden and Perriello, 1983). Effective recharge to the Clayton aquifer from infiltrating rainfall was estimated from a flow-net analysis to be 14.7 million gallons of water per day (MGD) (McFadden and Perriello, 1983). Effective recharge to the Claiborne aquifer was estimated to be 100 to 133 MGD by applying an infiltration rate determined from a digital ground-water flow model (Hayes and others, 1983) over the outcrop area (McFadden and Perriello, 1983). These values are rough, uncorroborated estimates. The Clayton and Claiborne aquifers probably receive recharge from other aquifers through leaky confining units; improperly constructed wells; and idle multiaquifer wells, when head differentials are conducive. Local areas of relatively large withdrawals from the Clayton aquifer may induce leakage from permeable units within the overlying Wilcox Group and Claiborne aquifer and the underlying Providence aquifer. Brine trace studies, in the Albany area, indicate that water from the Providence and Claiborne aquifers is recharging the Clayton aquifer through idle multiaquifer wells at a rate of 1.1 MGD (Hicks and others, 1981), which increases the effective recharge to the Clayton aquifer to 15.8 MGD. The Claiborne aquifer, probably, receives recharge from the Floridan aquifer in the Albany area where head differentials are favorable; however it has not been documented.

The Clayton and Claiborne aquifers discharge to the many streams in which they crop out, except when stream levels rise above aquifer water levels. Leakage from the Clayton and Claiborne to other aquifers is possible when head differentials are favorable. Tables 1 through 4 indicate that an estimated 98.26 MGD were withdrawn from the Clayton and Claiborne aquifers during 1986 for public supply, industrial, agricultural and self-supplied purposes.

Annual average withdrawals from the Clayton and Claiborne aquifers for public supply and industrial use are shown in Tables 1 and 2. Several multiaquifer wells are included; however, only the percent yield from either the Clayton or the Claiborne aquifer is reported. Percent yields from each aquifer were estimated from transmissivity maps, specific capacity tests, flow meter tests, interpolation techniques, and lengths of open intervals. Public suppliers and industries which withdraw more than 100,000 gallons of water per day (gpd) are required to obtain a ground-water use permit, under Georgia's 1972 Groundwater Use Act. An obligation of this permit is to report actual annual and monthly average water use on a biannual basis. Estimates for public suppliers which withdraw less than 100,000 gpd were made by city officials or utility superintendents. In some instances, withdrawals were estimated by multiplying 75 gpd per person (Barber,1987). Frequently, adequate information needed to estimate changes in annual withdrawals for some systems was not available. Annual ground-water withdrawal estimates for these systems are not represented as changing due to the lack of information.

Table 1 shows public supply and industrial annual average ground-water withdrawals from the Clayton aquifer, by county and user, for the years 1982 through 1986. Annual ground-water withdrawal totals indicate that during years with below normal precipitation, 1984 and 1986, (see Figure 3 on this plate) ground-water withdrawals increased relative to the previous year. When precipitation was above normal, 1982, 1983, and 1985, ground-water withdrawals were reduced. Albany, the largest single user, also reflects this trend. The City of Blakely's ground-water withdrawal dropped from 1985 to 1986. One of Blakely's three Clayton wells developed mechanical problems and its use was discontinued. The city had to rely on the two remaining wells which decreased their withdrawal significantly.

No apparent ground-water withdrawal trend is evident in the Claiborne aquifer between 1982 and 1986 (see Table 2). A trend in annual totals cannot be determined, since annual averages for some cities are incomplete. Albany withdrawals from the Claiborne aquifer increased every year since 1983. Miller Brewery withdrawals have decreased continually since 1982, when cost-awareness conservation measures were implemented. Great Southern Paper Company's conservation measures and leak repairs resulted in a decrease in withdrawals of almost 14 million gallons from 1985 to 1986. Cordele withdrawals increase annually, which may reflect increasing population and/or industrial growth. The population increase in Plains, approximately 200 people between 1983 and 1986, probably is the reason for Plains' increase in ground-water withdrawals.

Self-supplied ground-water withdrawal estimates, Table 3, were obtained by multiplying the self-supplied population in each county by 75 gpd per person (Barber, 1987). The self-supplied population was found by subtracting the population served by public supply systems from the total county population. The total county population was obtained from U.S. Bureau of the Census 1985 unpublished estimates. An estimated percent yield from each aquifer, in each county, was based on the extent of the shallowest significantly producing aquifer, published information concerning water resources in specific counties, and conversations with water-well drillers. The percent yield from each aquifer was applied to the total self-supplied ground-water withdrawal figure for each county, resulting in the values listed in Table 3. The Floridan and Cretaceous aquifers are included to illustrate relative aquifer use. The usage figures in Table 3 are purely hypothetical and, at best, are indicative of the relative usage of each aquifer in each county. Randolph County probably is the greatest user of the Clayton aquifer for self-supplied purposes. Terrell, Sumter, Randolph, and Clay Counties appear to rely heavily on the Claiborne aquifer for self-supplied demands.

Agricultural ground-water withdrawals were exempted from permitting under the 1972 Ground-Water Use Act. Some of the agricultural community participates in the voluntary water-use reporting survey conducted by the Ground-Water Use Program (GWUP). The paucity of submitted data prevents the determination of a representative agricultural withdrawal figure. The procedure outlined below was used to estimate agricultural ground-water withdrawals from the Clayton and Claiborne aquifers.

STEP 1 - Estimate the percent use of each aquifer in each county using the 1980 Soil Conservation Service's irrigation system inventory (U.S. Geological Survey, 1980) by:

- subtracting the total depth of the well from the land surface elevation to determine the elevation of the bottom of the well.
- determining which aquifer the well is completed in and assuming it is the sole source of water to the well (excludes multiaquifer wells).
- totaling the number of wells developed in each aquifer (Floridan, Claiborne, Clayton, or Providence) and the number of wells in each county.
- performing simple ratios on the number of wells in each aquifer to the total number of wells.

STEP 2 - Estimate the volume of ground water used for irrigation in each county by:

- multiplying the number of acres irrigated by the number of inches applied to specific crops to yield the total number of acre-inches irrigated in each county. In 1981, the number of times irrigated was reported rather than the number of inches applied. Then 1.5 inches were assumed to be applied during each irrigation cycle (based on oral communication with the Cooperative Extension Service). Acres irrigated and inches applied were collected from unpublished data from GWUP (U.S. Geological Survey, 1981, 1984, 1986).
- converting acre-inches to gallons using:
  1 gal. = .0000368 acre-inch
- deriving a percentage of ground water to surface water irrigation used in each county from the number of streams, ponds, and wells used as sources of irrigation water (based on unpublished data from GWUP, (U.S. Geological Survey, 1980).
- applying the percent use of ground water to the volume of water used to yield the volume of ground water used for irrigation in each county.

STEP 3 - Estimate the volume of water supplied by each aquifer in each county by:

- applying the volume of ground water used in each county from step 2 to the percent use of each aquifer from step 1.

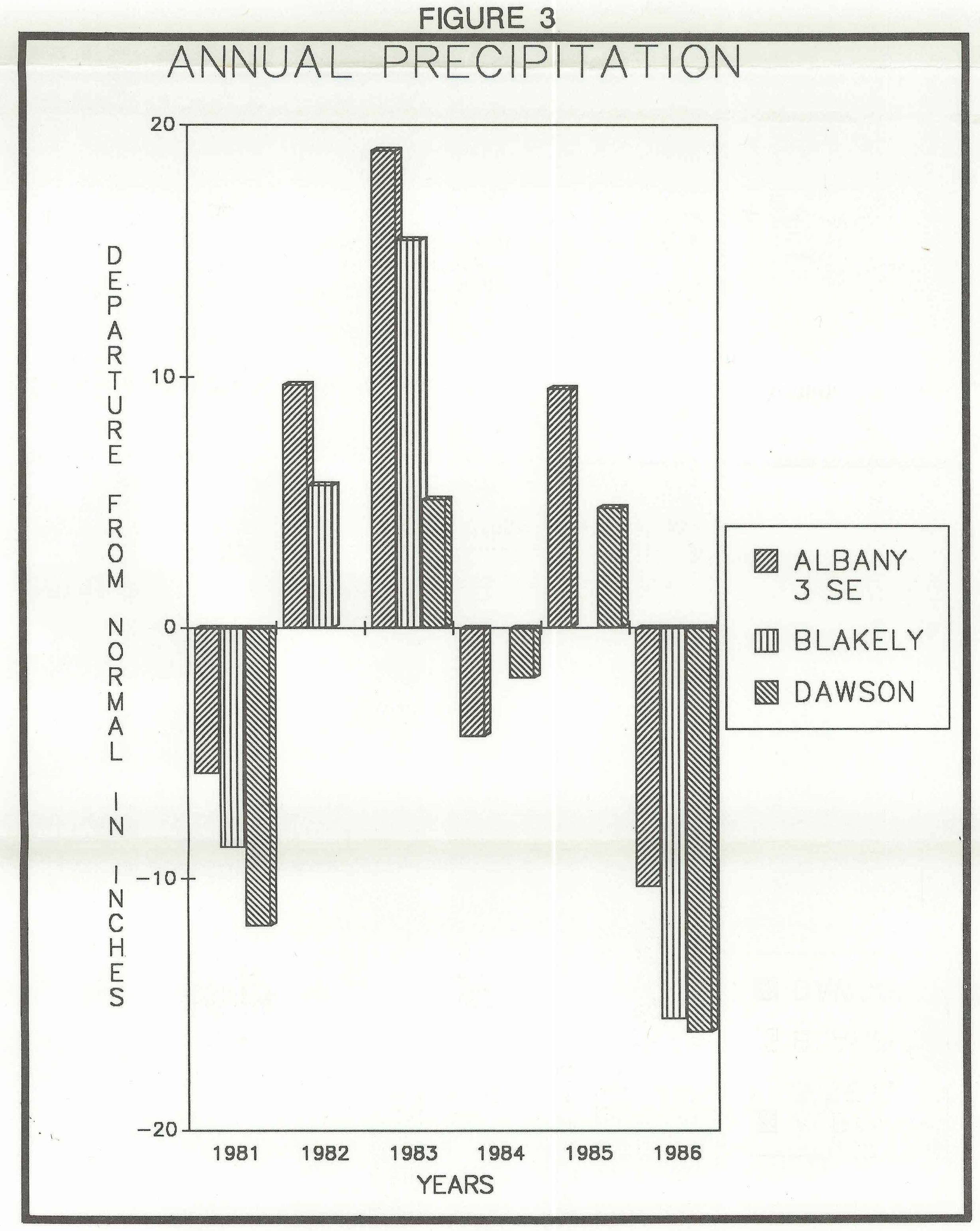
The relative use of the Floridan, Claiborne, Clayton, and Providence aquifers for irrigation was estimated for each county. Table 4 illustrates the estimated ground-water use for irrigation from the Clayton and Claiborne aquifers during 1981, 1984, and 1986. Except for Calhoun and Early Counties, ground-water withdrawals for irrigation decreased from 1981 to 1984 and increased from 1984 to 1986 This, generally, is due to the increased number of inches applied to crops in 1981 and 1986. Precipitation in the study area was significantly lower than normal during 1981 and 1986. The nearly doubled ground-water withdrawal totals during 1981 and 1986 indicate the added stress placed on the aquifers during droughts. This trend is not evident in every county. Variances are due to changes in acres irrigated, acres cultivated, inches applied, and type of crop grown. The increase in ground-water withdrawals from 1981 to 1986 in Calhoun and Early Counties is partially a result of increased acreage cultivated and hence irrigated.

Figure 1, on this plate, is a map showing the change in hydraulic potential of the Clayton aquifer between the years 1979 and 1986. It was produced by contouring point data derived from subtracting 1979 water levels from 1986 water levels. The area of greatest change on this map indicates that the largest declines in the Clayton aquifer are occurring in northeast Calhoun, southeast Randolph and southwest Terrell Counties. This is also indicated by the elongation of the cone of depression around Albany on the 1986 potentiometric surface map. These declines probably are caused by extensive irrigation withdrawals since there are no large permitted ground-water users in this area.

Figure 2, on this plate, is a map showing the change in hydraulic potential of the Claiborne aquifer between the years 1979 and 1986. A poorly defined area of change extends through portions of Dougherty, Lee and Dooly Counties. It probably results from local public supply and agricultural withdrawals. The isopotential level of water in the Claiborne aquifer appears to remain relatively stable over time.

An estimated 32.29 MGD were withdrawn from the Clayton aquifer in 1986. A 65.97 MGD were estimated to have been withdrawn from the Claiborne aquifer during 1986. These values suggest that more water is being withdrawn from the Clayton aquifer than is being effectively recharged (effective recharge is estimated to be 15.8 MGD), and approximately half of the water being recharged to the Claiborne aquifer (effective recharge is estimated to be 100-133 MGD) is artificially discharged. The estimated nature of the ground-water withdrawal data, especially agricultural and self-supplied, prevent quantifiable verification of these inferences. More accurate water use reporting standards, for all ground-water users, are needed in order to obtain accurate data to better manage the ground-water resources of the Clayton and Claiborne aquifers.

FIGURE 3



(Histogram produced from National Oceanic and Atmospheric Administration Climatological Data, 1981–1986)

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by
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1989

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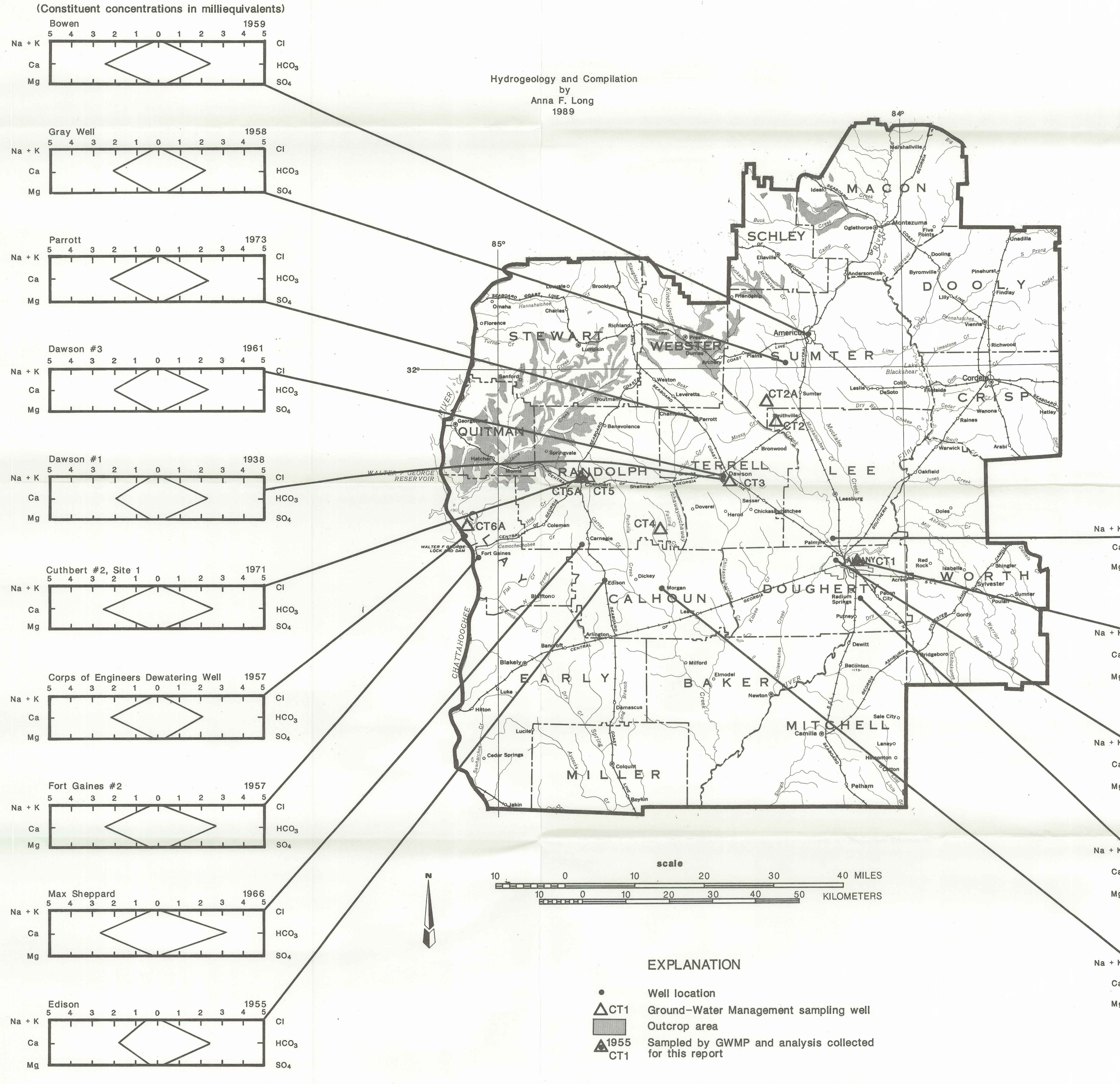
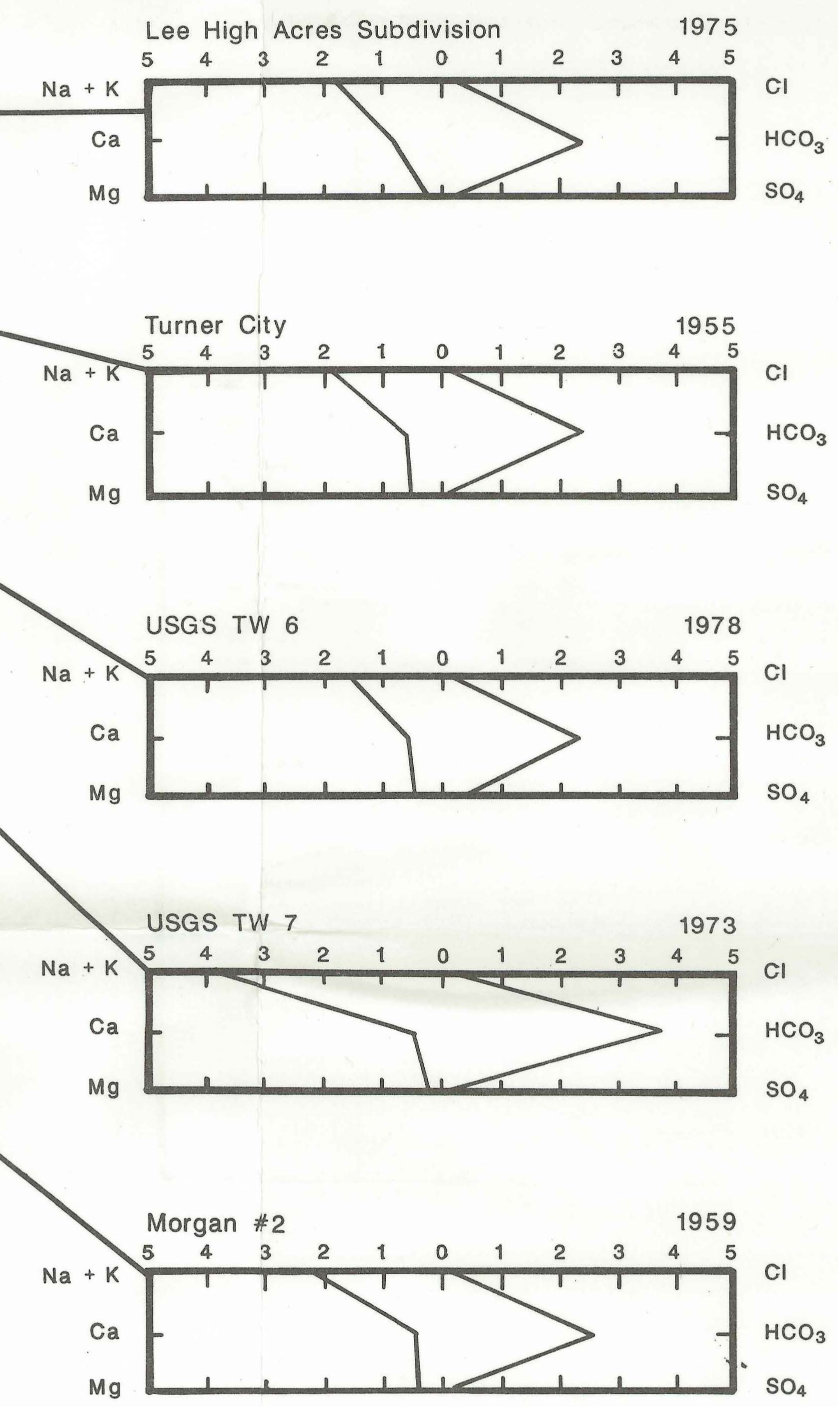
STIFF DIAGRAMS

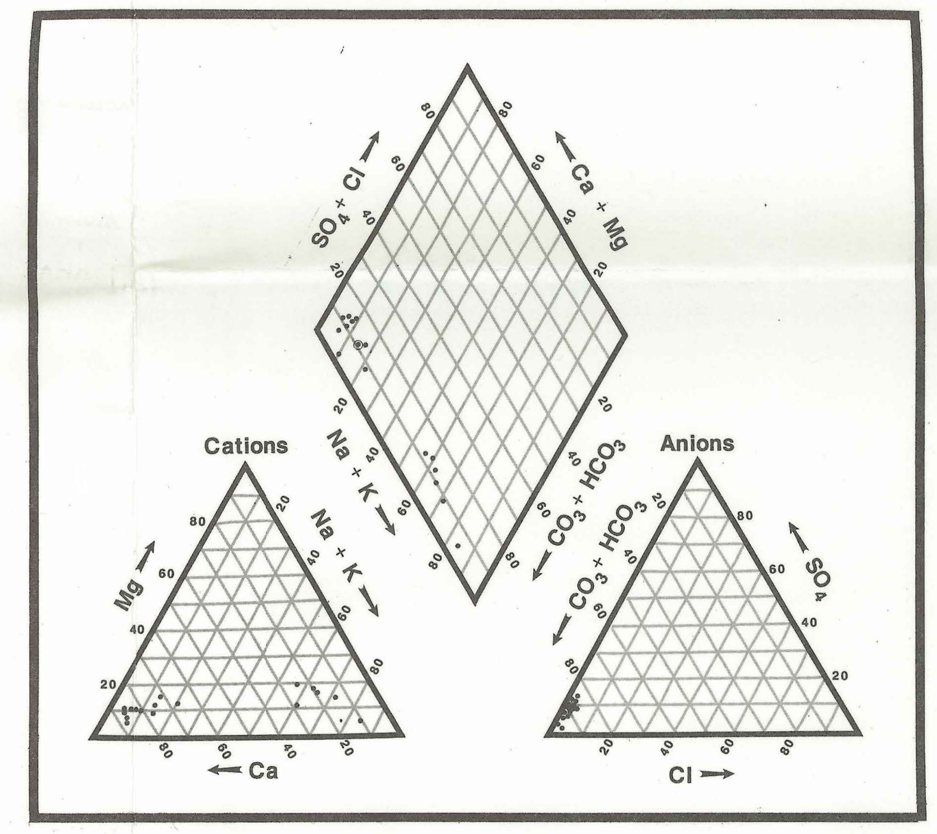
(Constituent concentrations in milliequivalents)





TRILINEAR (PIPER) DIAGRAM

(Constituent concentrations in percents)



Standard water quality analyses performed on samples extracted from 15 Clayton wells were used to describe the water quality of the Clayton aquifer. All 15 wells are developed where the Clayton aquifer is confined. The samples were collected and analyzed between 1938 and 1978. Comparison of sample analyses taken from the same well over subsequent years indicates that the water quality of confined aquifers changes very little over time, except in stressed areas where vertical leakage is induced. Therefore, analyses used in this report illustrate the water quality of the Clayton aquifer without respect to time.

Constituent concentrations were converted to milliequivalents from parts per million (ppm), using conversion techniques described in Hem (1985). Milliequivalent concentrations were plotted on Stiff diagrams (Freeze and Cherry, 1979). Where sodium and potassium concentrations were combined and reported as sodium, milliequivalent conversions were calculated using the conversion factor for sodium. Constituent percentages were determined from milliequivalents and plotted on a trilinear or Piper diagram (Freeze and Cherry, 1979) for convenient visual inspection.

Ground water typically is classified on the basis of constituent concentrations, which it acquires while flowing through the hydrogeologic framework. The Clayton Formation of Paleocene age has been divided into three units (see Plate 1, stratigraphic sequence). The lowermost unit is a basal conglomerate overlain by calcareous sand and sandstone beds that are locally arkosic, glauconitic, and fossiliferous. The middle unit is a fossiliferous, massive, recrystallized limestone containing various percentages of sand. The upper unit is a calcareous silty sand interbedded with thin limestone and clay beds. The middle limestone unit of the Clayton Formation makes up the Clayton aquifer. Locally, permeable sand units in the upper and lower units are hydraulically connected with the limestone unit and are considered part of the aquifer.

Ground–water quality in the Clayton aquifer generally is good and meets the standards outlined in the Georgia Safe Drinking Water Act of 1977. Ground water in the Clayton aquifer is of two types. Stiff diagrams to the left-hand side of the location map are characteristic of calcium bicarbonate type water. The Stiff diagrams to the right of the location map indicate sodium bicarbonate type water. The cation trilinear diagram shows two distinct areas of concentration: calcium to the left and sodium and potassium to the right. This distinction also is present on the combined cation-anion diamond.

The calcium-magnesium concentration in the calcium bicarbonate type water ranges from 39.8 to 59.7 ppm, or 105.5 to 154.5 milligrams per liter of calcite (mg/L of CaC03), which is indicative of moderately hard to hard water. Chloride and sulfate levels are uniformly low, ranging from 7.0 to 19.2 ppm. Sodium and potassium concentrations remain relatively constant throughout the calcium bicarbonate area, ranging from 2.8 to 14.0 ppm.

Samples from the downdip Albany and Morgan areas are sodium bicarbonate in nature. Based on the definition of hardness (Hem, 1985) these analyses are indicative of soft water; calcium-magnesium concentration ranges from 11.0 to 18.8 ppm, or 31.5 to 53.0 mg/L of CaC03. Sodium and potassium concentrations range from 35.8 to 83.1 ppm. Chloride and sulfate levels remain relatively low throughout the area containing sodium bicarbonate type water.

The calcium bicarbonate type water is derived from dissolution of the calcitic framework of the Clayton aquifer by carbonic acid. Wells containing this type of water probably do not receive large yields of water from the lower unit of the Clayton Formation. The sodium bicarbonate type water in the Albany area may be a result of leakage from the underlying Providence Sand, leaching of arkosic sands in the lower Clayton Formation, or a combination of the two. Leakage from the underlying Providence Sand into the Clayton aquifer through idle multiaquifer wells has been documented in the Albany area (Hicks and others, 1981 and Clarke and others, 1984). The wells containing sodium bicarbonate type water are completed near the base of the Clayton Formation. Wells that penetrate the arkosic sand, beneath the limestone, produce water with high sodium contents (Wait, 1960).

A facies change occurs in the Clayton Formation to the south of Albany (McFadden and Perriello, 1983). The limestone unit thins and the clay content increases. Sodium in clay minerals commonly is exchanged for calcium in ground water. (Hem, 1985). The reversed ground-water flow gradient caused by the Albany cone of depression (illustrated on Plate 2) may be pulling water from this clay rich area. The sodium bicarbonate water in the Morgan municipal well may be directly from the Providence Sand. The well construction information on this well is vague and there is a possibility that it may end in the Providence Sand.

The Georgia Ground-Water Management Program (GWMP) samples seven updip confined wells and one downdip confined well in the Clayton aquifer, once a year. Analyses in this report generally coincide with GWMP analyses from the Clayton aquifer. The GWMP detected iron in excess of acceptable levels for domestic use in water from three updip wells. The testing program has not detected any pollutants in the Clayton aquifer in these wells.

WATER QUALITY AND CHEMISTRY – CLAIBORNE AQUIFER

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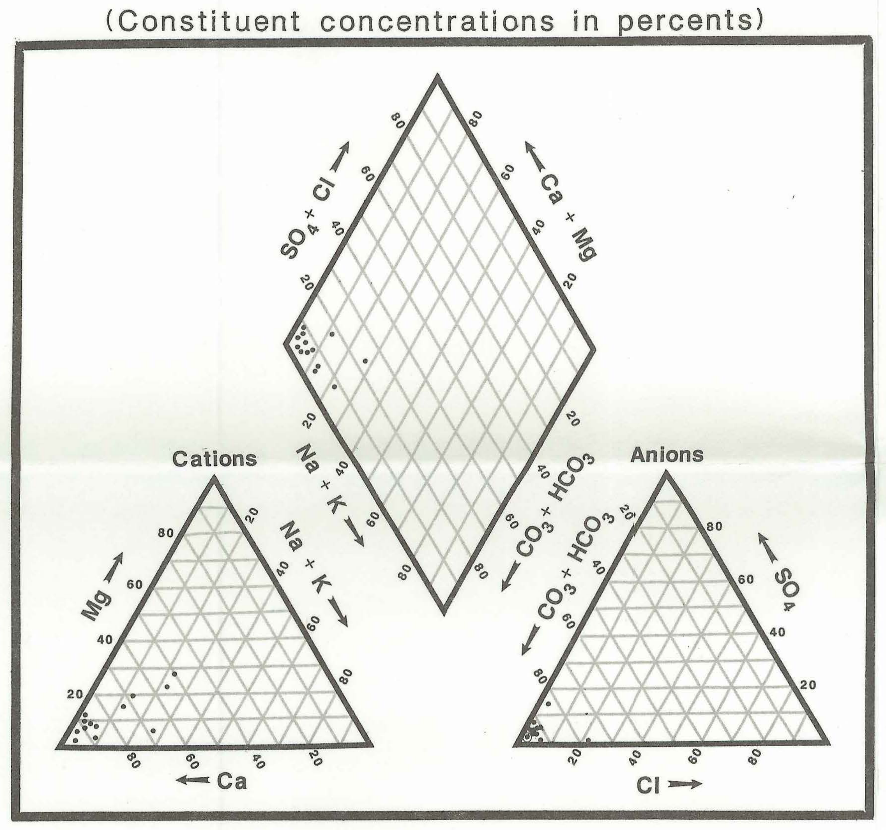
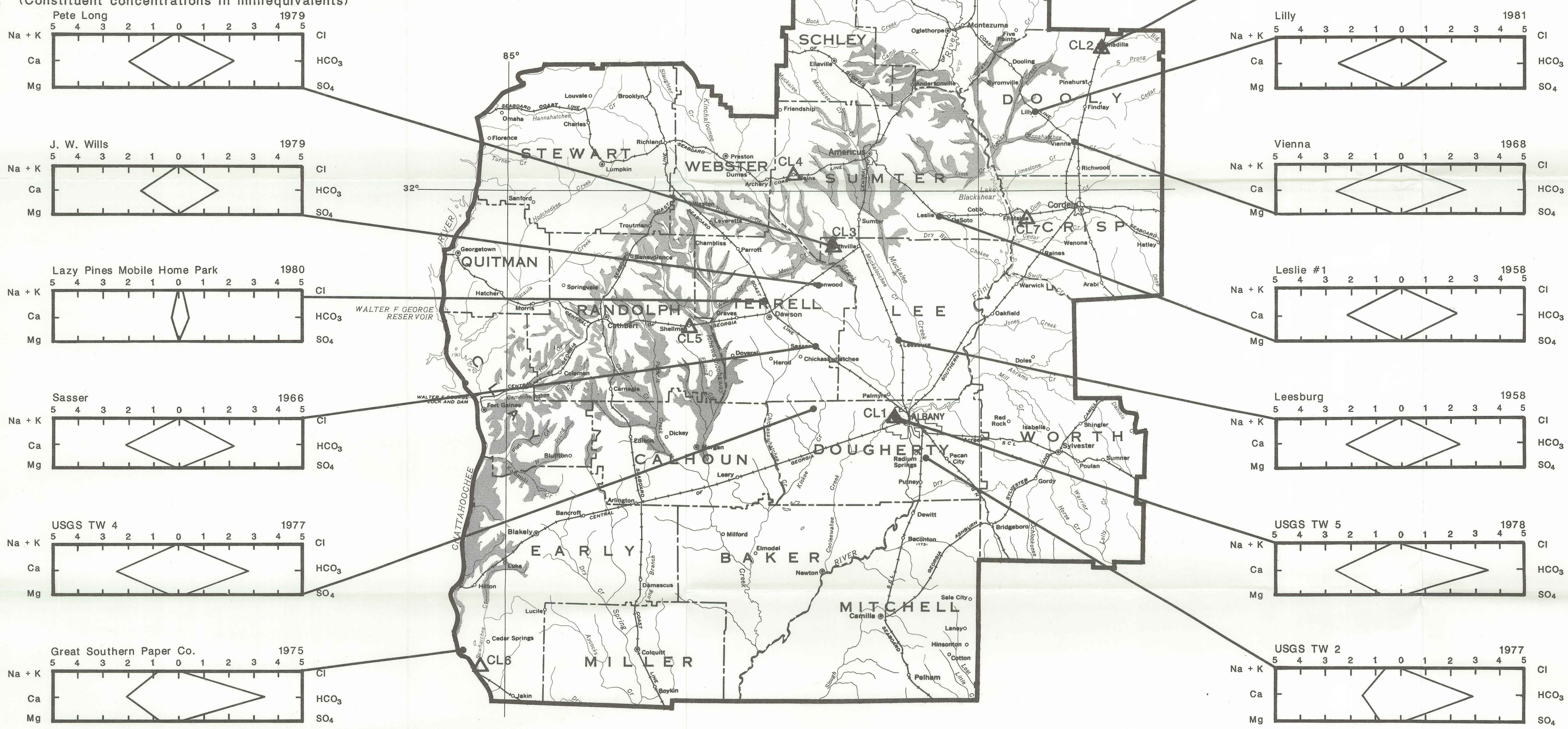
TRILINEAR (PIPER) DIAGRAM
(Constituent concentrations in percents)



STIFF DIAGRAMS
(Constituent concentrations in milliequivalents)



scale

10 0 10 20 30 40 MILES

10 0 10 20 30 40 50 KILOMETERS

EXPLANATION

- ● Well location and sample year
- △CL1 Ground-Water Management sampling well
- ▭ Outcrop area
- 1978 △ CL1 Sampled by GWMP and analysis collected for this report

Water quality analyses performed on samples from 13 Claiborne wells were collected in order to describe the water quality of the Claiborne aquifer. All wells sampled are in the confined portion of the Claiborne aquifer. The samples were collected and analyzed between 1958 and 1981. The water quality of the Claiborne aquifer is described in this report without respect to time.

Constituent concentrations in parts per million (ppm) were converted to milliequivalents and plotted on Stiff diagrams (Freeze and Cherry, 1979). Conversion constants and procedures are specified by Hem (1985). When sodium and potassium concentrations were combined and reported as sodium concentrations, milliequivalent conversions were performed using the sodium conversion factor. Percentages of constituents were calculated from the milliequivalents and plotted on a trilinear or Piper diagram (Freeze and Cherry, 1979) for additional illustration.

Water flowing through an aquifer may acquire a diagnostic chemical composition from interaction with the aquifer sediments. The Claiborne Group is comprised of the Lisbon and Tallahatta Formations of middle Eocene age (see Plate 1, stratigraphic sequence). The Lisbon Formation consists of calcareous, fossiliferous, glauconitic, sands, limestone, and clayey sands that locally are indurated (Marsalis and Friddell, 1975). The Tallahatta Formation is a fossiliferous, slightly calcareous, glauconitic, clayey sand. Saturated permeable sands within the Tallahatta Formation generally form the Claiborne aquifer. In some areas, saturated permeable sands in the lower part of the overlying Lisbon Formation and the upper part of the underlying Hatchetigbee Formation are hydraulically connected with the Tallahatta sands and are considered part of the Claiborne aquifer (McFadden and Perriello, 1983).

Claiborne aquifer water quality is good and meets the standards outlined in the Georgia Safe Drinking Water Act of 1977. Water within the Claiborne aquifer is calcium bicarbonate in type as illustrated by the geometric shapes on the Stiff diagrams and the cluster of points on the trilinear diagrams. The water generally is basic (pH > 7) with one exception. The pH value of the water from the Lazy Pine Mobile Home Park well in Terrell County was 6.6. The analysis from this well indicates a calcium bicarbonate type water but constituent concentrations are extremely low relative to other analyses. The close proximity of this well to the outcrop/recharge area would result in a short aquifer residence time before being withdrawn from the well. Short residence time could result in the low concentrations in addition to the acidity. This analysis is not included in the following general description of ranges of constituent concentrations within the Claiborne aquifer.

Calcium and magnesium concentrations cause most of the hardness in water. Calcium and magnesium concentrations in the Claiborne aquifer ranged from 32.0 to 60.3 ppm, or 83.0 to 163.5 milligrams per liter of calcite (mg/L CaC03), which is indicative of moderately hard to hard water. Chloride and sulfate levels are relatively low throughout the study area, ranging from 3.8 to 22.0 ppm. Sodium and potassium concentrations also are uniformly low, ranging from 1.0 to 17.3 ppm. Sodium and potassium, magnesium, and bicarbonate concentrations seem to increase slightly downdip in the aquifer. This is evident from analyses of water from U.S. Geological Survey test wells (USGS TW) 2 and 5 in Dougherty County, and in the Great Southern Paper Company well in Early County.

The dissolution of carbon dioxide in water produces carbonic acid. Carbonic acid, in ground-water environments, causes the dissolution of calcite into calcium and bicarbonate ions. Therefore, as ground water flows through the calcareous portions of the Claiborne aquifer, it becomes enriched in calcium and bicarbonate. Magnesium is a common constituent in sedimentary carbonates. Dissolution of limestone releases magnesium into solution. This process is not readily reversible and causes magnesium concentrations to increase along ground-water flow paths (Hem, 1985). Sodium and potassium ions probably are leached from the clay minerals in the Lisbon and Tallahatta Formations. The slight increase in sodium, potassium, magnesium, and bicarbonate concentrations in the downdip area of the aquifer most likely is a result of longer residence time in the aquifer.

The Georgia Ground-Water Management Program (GWMP) samples a network of monitoring wells in the Claiborne aquifer on an annual basis. The network contains wells in the unconfined and confined areas of the aquifer. Analyses performed on samples from the confined area agree with analyses described in this report.

Analyses on samples from the unconfined areas differ markedly (Davis and Turlington, 1987). Ground water in the unconfined areas of the Claiborne aquifer tends to be acidic, corrosive, and soft. Iron and/or manganese concentrations in excess of drinking water standards were present in outcrop wells. Trace amounts of yttrium and cobalt were encountered in the outcop area. The GWMP detected relatively high amounts of nitrites/nitrates in three wells, but has not yet determined whether the relatively high amounts of nitrites/nitrates are natural or a result of pollution. Other pollutants have not been detected in the aquifer.

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