GROUND WATER CONDITIONS
IN THE CLINTON AREA,
NORTH CAROLINA

by

Leland L. Laymon and Robert G. Barksdale

Ground Water Circular No. 3

North Carolina
DEPARTMENT OF WATER RESOURCES
Walter E. Fuller, Director

DIVISION OF GROUND WATER
Harry M. Peek, Chief

1964

C O N T E N T S

I L L U S T R A T I O N S

INTRODUCTION

In the spring of 1964, the North Carolina Division of Ground Water conducted an investigation of the ground-water resources in the vicinity of Clinton in Sampson County, North Carolina. The purpose of this investigation was to appraise the ground-water conditions in the Clinton area with special emphasis on determining the availability of an adequate future water supply from wells for municipal and industrial uses.

The field work for this investigation was carried out from March to July of 1964 under the direct supervision of Harry M. Peek, Chief, Division of Ground Water. It included reconnaissance geologic mapping and the location and observation of about 40 wells from which data was obtained. Preliminary chemical analyses were run on water samples collected from selected wells in the area. The geologic work also included electric and gamma logging along with detailed study of well cuttings from several key wells in the area for subsurface geologic control. One major pumping test was conducted for study of aquifer properties.

Acknowledgment

The writers wish to acknowledge the courteous cooperation of the officials of the City of Clinton, the Lundy Packing Company and to the drillers who contributed important information concerning the area during this investigation.

Geography

The area of investigation is located within four five-minute quadrangles in the east-central portion of Sampson County in and around the City of Clinton. It is bounded on the north by longitude 35°05' and on the south by longitude 34°55'. Boundaries on the east and west are latitudes 78°15' and east 78°25' west (fig. 1).

The area of investigation is in the Coastal Plain province and forms a part of a broad, flat to gently rolling plain, the upland surface of which slopes toward the southeast. At Clinton, this plain lies at an elevation of about 100 to 170 feet above sea level, but has been dissected by Great Coharie Creek and Run Creek, whose valleys are as much as 80 feet deep at some places.

The average annual precipitation over a period of the last 27 years was 45.59 inches with the highest precipitation occurring in July and lowest in November (fig. 2). Much of the rainfall is absorbed by the permeable surficial sands. That which is not absorbed or lost by evaporation is discharged into Great Coharie Creek on the west and into Run Creek on the east, the principal drainage for the Clinton area.

Based on the 1960 census the population of the area covered by this report is about 11,500, with 7,500 of these in the City of Clinton.

There are four industries employing fifty or more persons and twenty-two others employing less than fifty persons. Thirty percent of the industries are engaged in the preparation of food products and another thirty percent in lumber and wood products. The remaining industries are engaged in widely diversified products or processes.

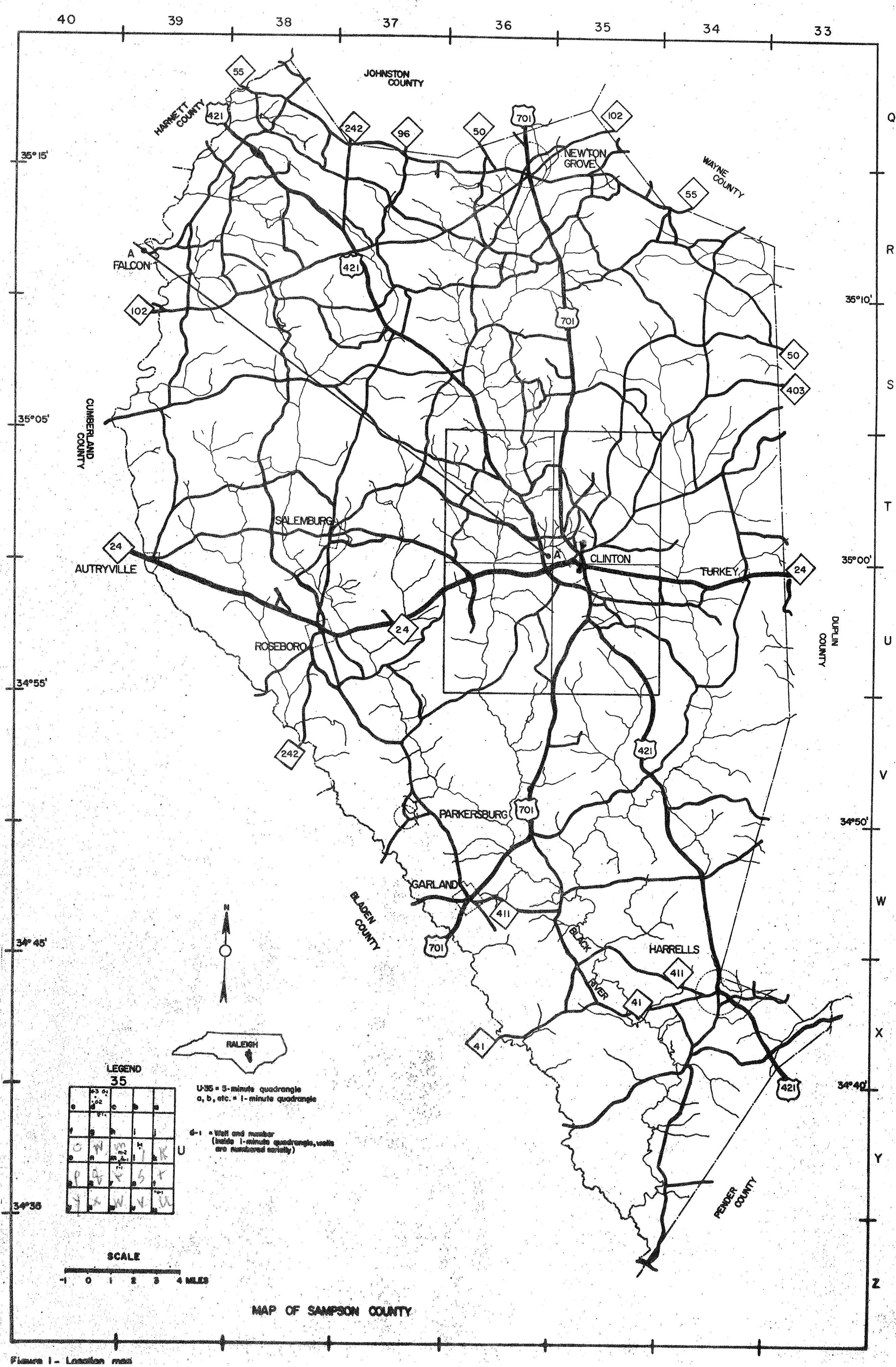

Figure 1 - Location map

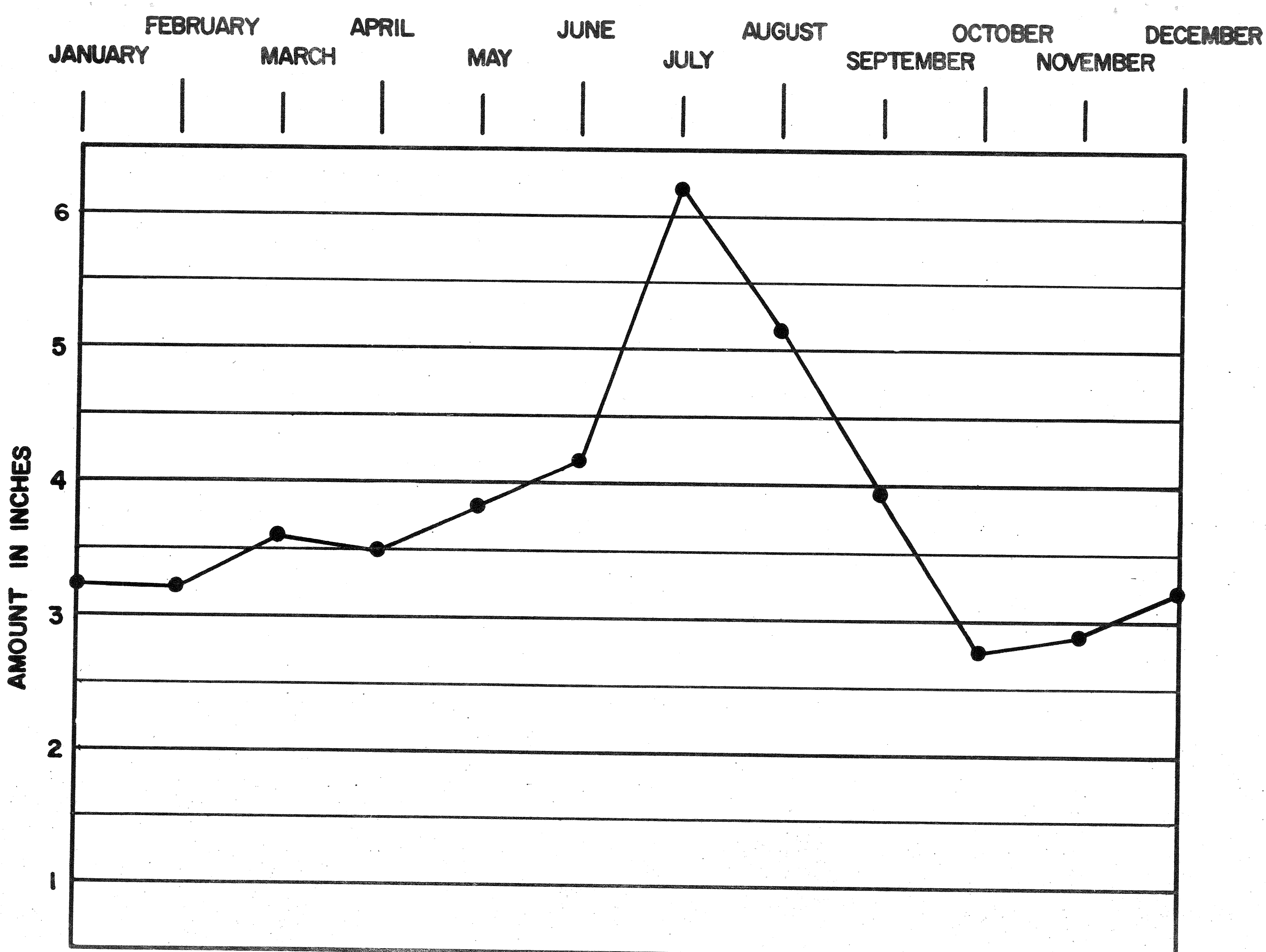

FIGURE 2 – AVERAGE MONTHLY PRECIPITATION FROM JANUARY [illegible] THRU [illegible]

The four largest industries employ about thirty percent of the labor force.

Well Location and Numbering System

The location and numbering of wells in this report is based on a state-wide grid system of longitude and latitude.

The State is divided into quadrangles of five-minutes latitude, identified by upper case letters and five-minutes longitude, indentified by numbers. Each five-minute quadrangle is divided into 25 one-minute quadrangles, identified by lower case letters. The wells in each one-minute quadrangle are numbered serially. Thus, a well numbered "U-35, u-4" would be well number 4 in the one-minute quadrangle "u" of the five-minute quadrangle U-35 (fig. 1).

GEOLOGY

The principal geologic units of Sampson County are shown in the generalized cross section in figure 3, and include sedimentary rocks ranging in age from Cretaceous to Recent. The sediments rest on crystalline "basement" rocks similar to those of the Piedmont, and have a regional dip of about ten feet per mile toward the southeast. The thickness of the sediments also increases toward the southeast.

In the vicinity of Clinton, these sediments have a local dip of about 20 feet per mile toward the southeast and have a thickness of at least 450 feet and probably more than 500 feet (fig. 4).

The late Cretaceous sediments have been divided into two formations the Black Creek and Tuscaloosa.

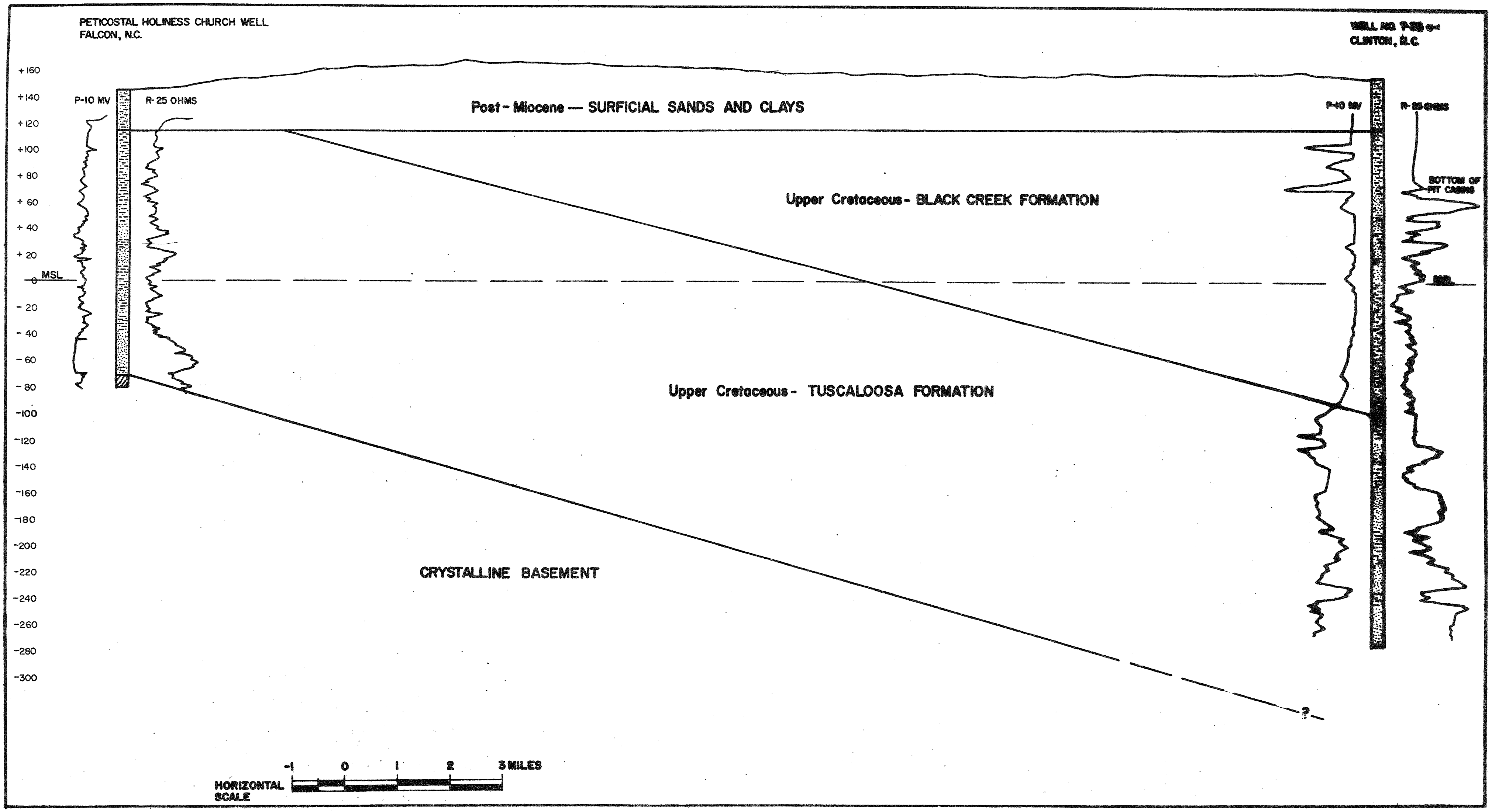

Figure 3 – Geologic Cross Section A-A'

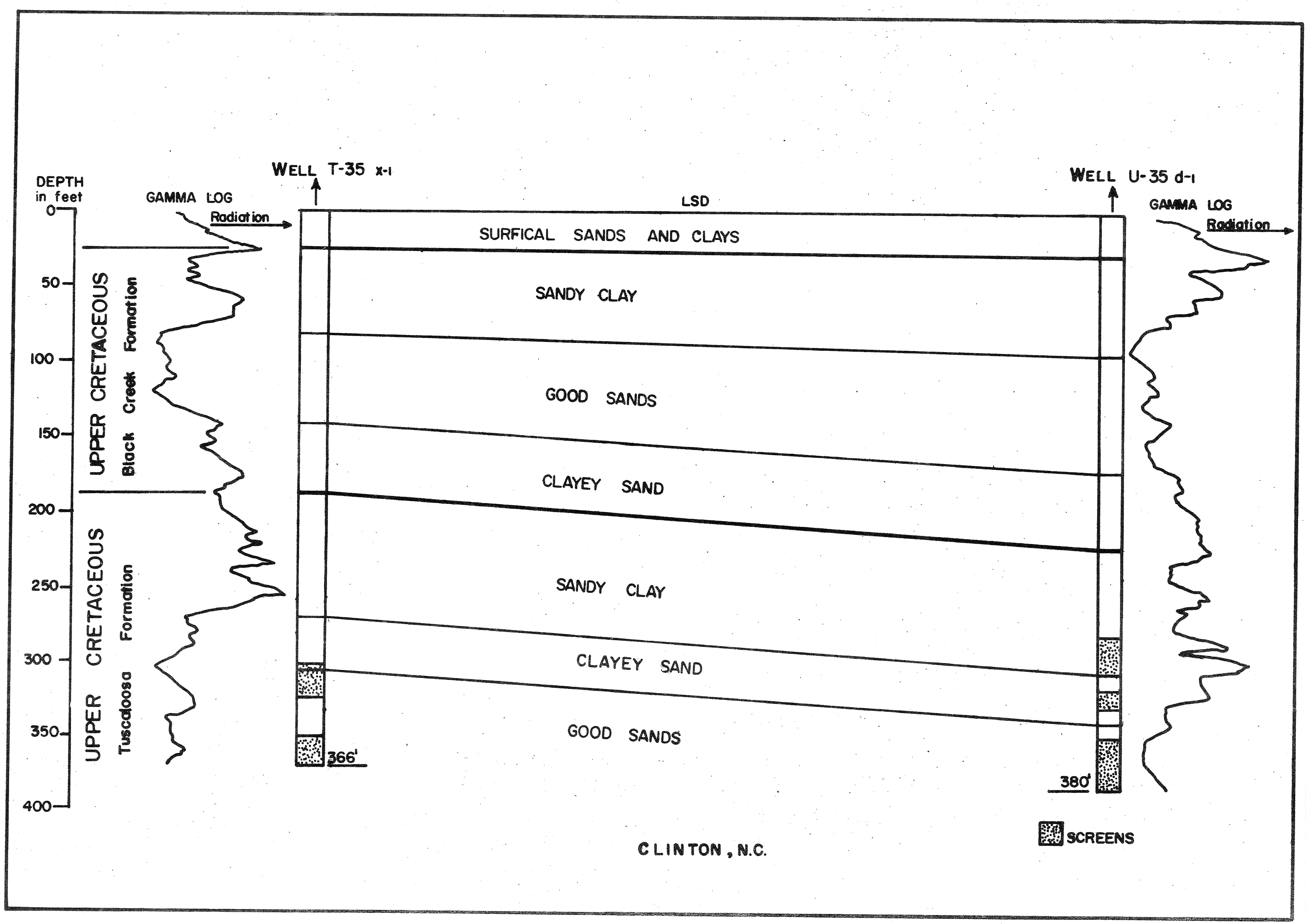

Figure 4 - Geologic cross-section B-B'

The Tuscaloosa, being the oldest formation, rests on the basement rocks and is composed mostly of grey to red sand, gravel and clay. The formation ranges in thickness from 200 to 300 feet and contains several thick beds of medium to coarse grained sand that comprises the principal aquifer of the area.

Overlying the Tuscaloosa is the Black Creek formation, composed mostly of thin beds of brownish to black, micaceous clay alternating with thin beds of grey to white, medium grained sand. The occurrence of lignitized wood and pyrite is common throughout the formation, which ranges in thickness from about 100 to 200 feet. This formation contains beds of sand capable of yielding considerable amounts of water, but the quality is generally less suitable for public supplies than the water in the Tuscaloosa formation.

Surficial sands and clays probably of Pliestocene age and younger, lie unconformably on the Black Creek formation and range in thickness from 0 to 40 feet. In the major streams and valleys it has been eroded away exposing the older formations.

GROUND WATER

Ground water is the subsurface water in the zone of saturation, the zone in which all pore spaces are filled with water under hydrostatic pressure. An aquifer is a rock unit or group of rock units that are water bearing.

When precipitation falls on the surface a part of it enters the soil and continues downward to the zone of saturation, the top of which is called the "water table". This water moves laterally to a place of discharge such as a creek, spring or well. This lateral movement may take place under artesian or non-artesian conditions. Water that is said to be under non-artesian or water table conditions is subject to the rise and fall of atmospheric pressure. Water that is overlain and underlain by relatively impermeable beds is not subject to the rise and fall of atmospheric pressure and is said to occur under confined or artesian conditions. The piezometric surface of an artesian aquifer is an imaginary surface representing the height above sea level that water will rise in tightly cased wells that penetrate the artesian aquifer (fig. 5).

Recharge

The water in the surficial sands, which is the source of supply for the many shallow wells in the vicinity of Clinton, occurs under water-table conditions and is recharged from precipitation in the immediate area. The water in the deep sand strata of the Cretaceous formations occurs under artesian conditions, being confined by overlying beds of clay. Thus, most of the recharge to these aquifers is from precipitation that occurs outside the immediate area.

Use of Ground Water

Domestic water supplies outside the City of Clinton are obtained from individual wells bored, jetted or dug to depths of 20 to 40 feet in the surficial sands.

The City of Clinton presently obtains its water supply from three deep wells (T-35, x-1, U-35, d-1 and U-35, d-2 in table I) which yield 380, 240 and 620 gpm respectively or 1,785,000 gallons per day (gpd). Water from these three wells is pumped directly into the

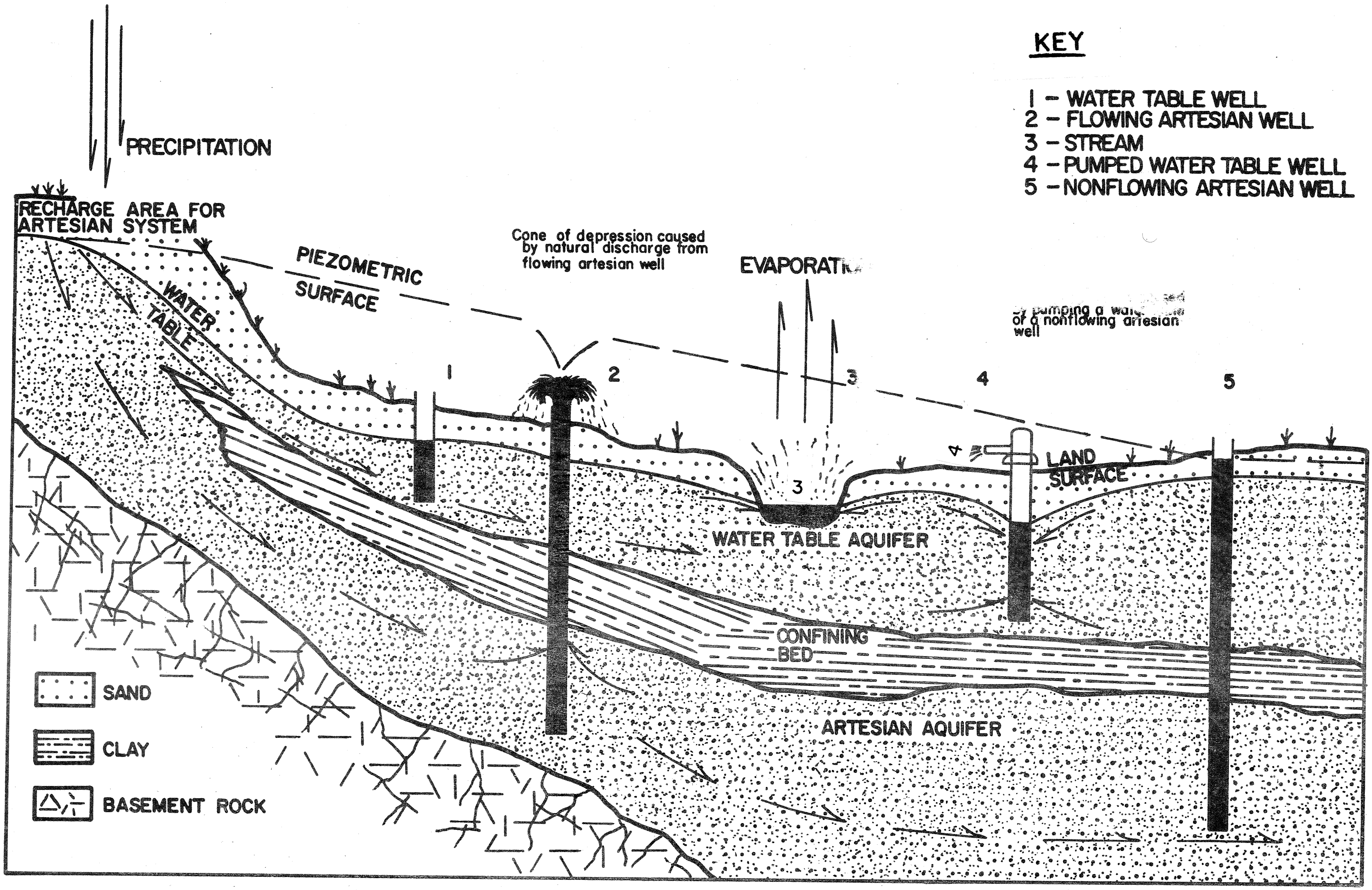

Figure 5 - Diagram showing some principles of ground water occurence

distribution system, which is in turn connected to three elevated storage tanks with a total capacity of 375,000 gallons. The pumps are automatically controlled so that when the water level falls to a certain level in the tanks, one, two or all of the wells could be called upon to supply the system with additional water. Treatment of the water by chlorine is performed at each well.

Use of water by the City of Clinton ranges from 800,000 to 1,000,000 gpd with about half of this amount being used by the Lundy Packing Company for processing pork products. Future industrial prospects indicate that an additional supply of about 750,000 gpd will be required in the immediate future.

The waste products are processed through a treatment plant with a capacity of 2.5 million gpd before being discharged into Williams Old Mill Branch.

In addition to the city wells, there are two privately-owned deep wells in the city. One is used for irrigation, owned by Henry Vann (T-35, y-2) and the other is owned by the Lundy Packing Company (U-35, d-3). The Lundy well is not in use at the present time, but will supply the company with at least 600 gpm and allow it to become independent of the city supply.

Quantative Ground-Water Studies

The withdrawal of water from an aquifer causes water levels to decline in the vicinity of the point of withdrawal. The amount by which water levels are lowered by pumping is governed by several factors. These include (1) the rate of pumping, (2) the water-transmitting and water-storage characteristics of the aquifers, (3) the extent of the aquifer, and (4) the location and quantity of recharge and natural discharge.

Aquifers function in two capacities--as conduits that transmit water and as reservoirs that store water. The measure of an aquifer's capacity to transmit water is its coefficient of transmissibility, which is defined as the rate of flow of water, in gpd, at the prevailing water temperature, through each vertical strip of the aquifer one foot wide having a height equal to the thickness of the aquifer, under a unit hydraulic gradient. The measure of an aquifer's capacity to store water is its coefficient of storage, which is defined as the volume of water it releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. The coefficients may be determined by means of pumping tests and may be used along with the specific capacity, yield in gallons per minute per foot of drawdown, of a well to estimate the resultant decline in water levels to various rates of pumping.

Pumping tests --- Pumping tests were made on the City of Clinton's wells to obtain data for computing the above-mentioned coefficients. Well U-35, d-2 was pumped at a rate of 612 gpm for 26 hours, and the drawdown was measured in U-35, d-3. Analysis of the data indicated that the aquifers in the Tuscaloosa formation have a coefficient of transmissibility of 70,000 gpd-ft. and a coefficient of storage of 0.000562 with a specific capacity of 12.5 gallons in well U-35, d-3. After applying these coefficients to other pumping test data it was possible to determine the amount of interference caused by each pumping well and its areal extent. Interference is the combined effect that two more wells have on each other and the piezometric surface during periods of pumping (fig. 6).

Figure 7 is a contour map of the piezometric surface after 12 hours of continuous pumping of wells T-35, x-1, U-35, d-1, d-2, and d-3. This map shows the areal extent of interference of the combined wells and hence permits the selection of future well locations so as to minimize any additional interference. On the basis of the quantitative studies of wells and available geologic information, future wells should be located south of the railroad and wells producing 400 gpm or more should be located at least 4000 feet from any existing well.

Quality of Water

Ground water contains chemical elements in concentrations which are generally dependent upon the mineral composition of the rocks through which it moves and the amount of time the water has been in contact with the rocks. Bacteriological pollution of ground water aquifers is extremely rare and the chances of pollution from the surface through the well are very slight when the well has been properly constructed.

Most of the water from wells finished in the Recent surficial material and the Black Creek formation is very soft and contains high amounts of iron and has a very low pH. Hydrogen sulfide occurs locally in some of the wells finished in the Black Creek.

Wells finished in the Tuscaloosa formation yield water of very good quality. The pH ranges from 7.5 to 8.5 with the iron and maganese

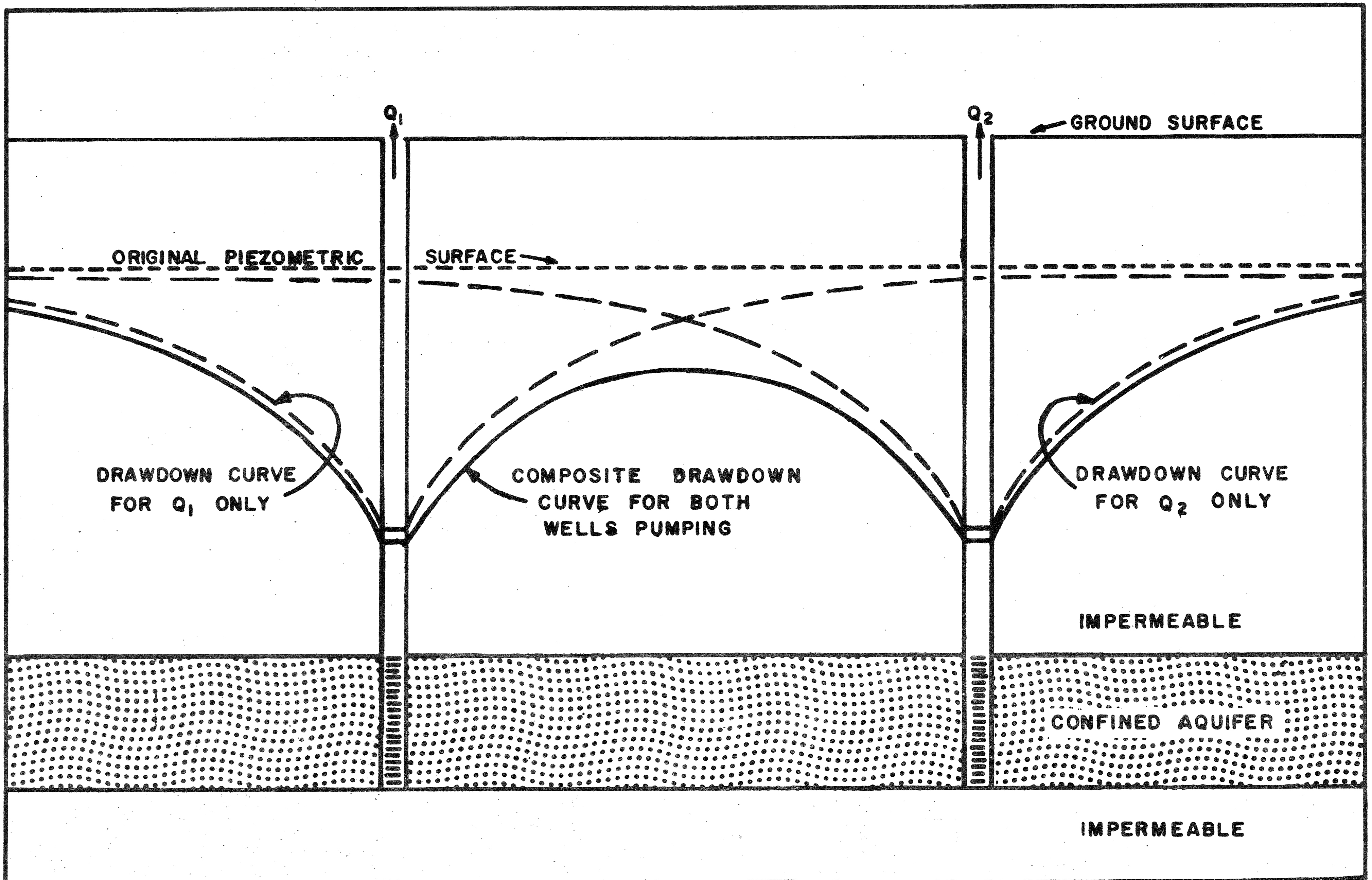

FIGURE 6— INDIVIDUAL AND COMPOSITE DRAWDOWN CURVES OF TWO PUMPING WELLS.

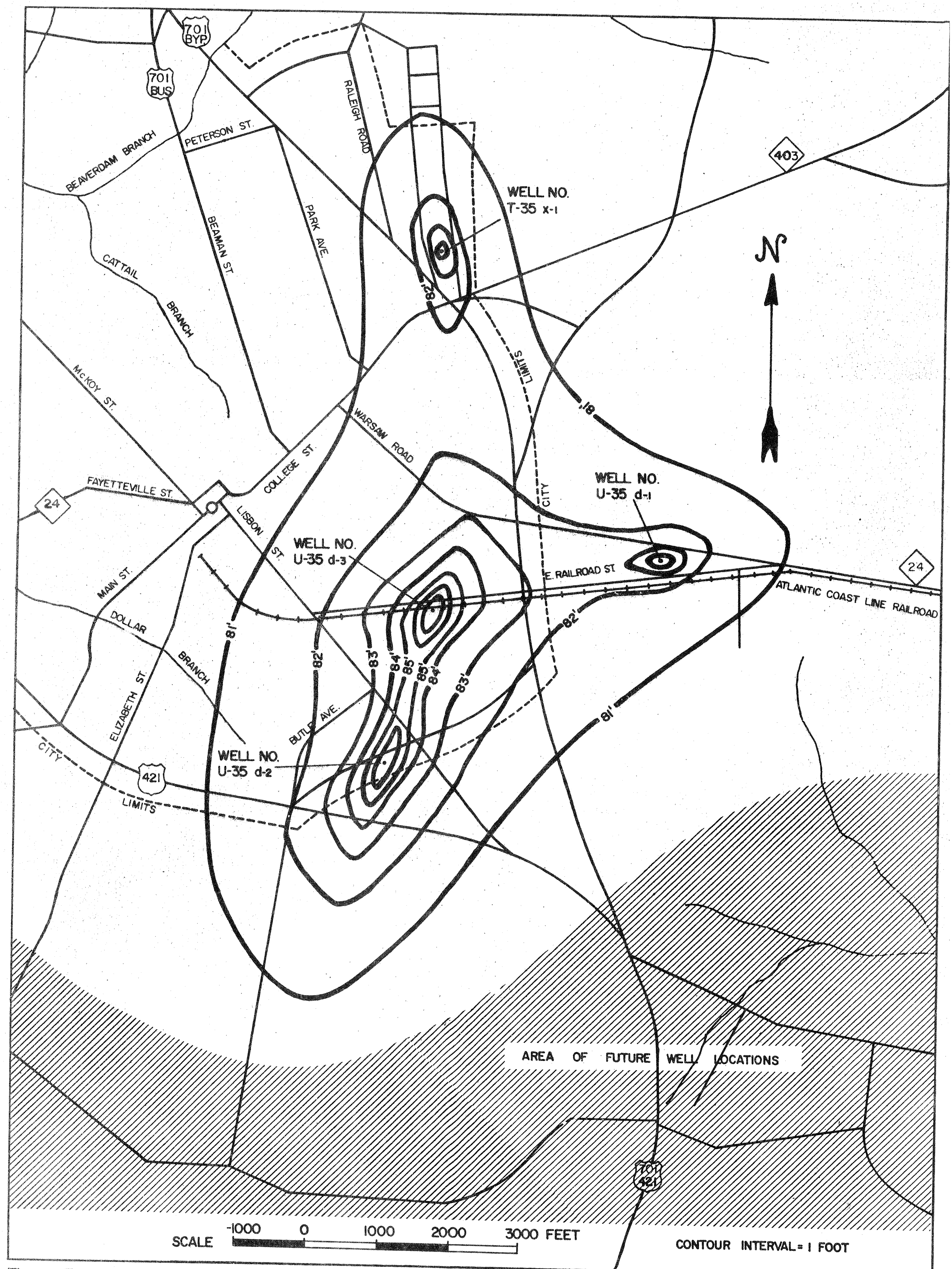

Figure 7 - Piezometric surface after twelve hours of continuous pumping

being between .05 ppm and .25 ppm. Water hardness ranges from soft to moderately hard.

Chemical analysis of water from selected wells is shown in tables I and II.

Screen Incrustation --- All ground water normally contains some free carbon dioxide, which is a gas absorbed by the water when it falls as rain and as it seeps into the ground. The capacity of water to absorb and hold carbon dioxide depends upon temperature and pressure. The combination of carbon dioxide with water forms carbonic acid. Water that contains carbon dioxide gas can take into solution considerable quantities of calcium carbonate and similar incrusting materials as it passes through the formation. (1)

When water is pumped from a well, a hydraulic gradient toward the well is established which causes the water to flow into the well. As the water enters the well bore, there is a sudden change in velocity which results in a change in pressure. This change in pressure causes the carbon dioxide gas to be released. As the gas escapes, the water is unable to retain all of the dissolved mineral matter in solution and, therefore, most of it is deposited around the well. Due to the fact that the greatest change in velocity is right at the well, the greatest amount of incrusting material is deposited on the screen and in the formation material immediately adjacent to the well. As incrustation fills the openings in the screen and the aquifer, the yield of the well decreases accordingly.

Several means of reducing screen incrustation can be applied. Probably the most important method of preventing incrustation is the use of a screen that permits the water to enter the well with the least resistance possible and thus, the lowest velocity. Another effective measure is construction of wells of sufficient diameter to permit low entrance velocities. For example, the velocity of water flowing into a six inch well is more than three times greater than the velocity of water flowing into a twenty inch well.

The velocity may also be reduced by decreasing the pumping rate and increasing the pumping period. There are a number of cases on record where incrustation problems have been greatly reduced by pumping a smaller quantity of water per minute and pumping over a longer period of time. It should be kept in mind that the most economical operation of both pumps and wells is obtained when pumping is as continuous as is practical.[1]

Periodic maintenance or cleaning procedures can also help reduce incrustation. The Johnson Well Screen Company recommends that a well should be cleaned every eight months to a year whether or not the yield has fallen off. It is much eaiser to remove small amounts of incrustation than to remove quantities that have caused the yield to decrease. As shown in figure 8, the incrustation and/or corrosion on the screens was removed after a thorough cleaning of each well. Cleaning of these wells increased the yields considerably.

SUMMARY AND RECOMMENDATIONS

Moderate quantities of good quality water can be obtained from sands in the Tuscaloosa formation for municipal and industrial supplies. Considerable quantities can also be obtained from the Black Creek formation; however, the water is of poorer chemical quality than that of the Tuscaloosa.

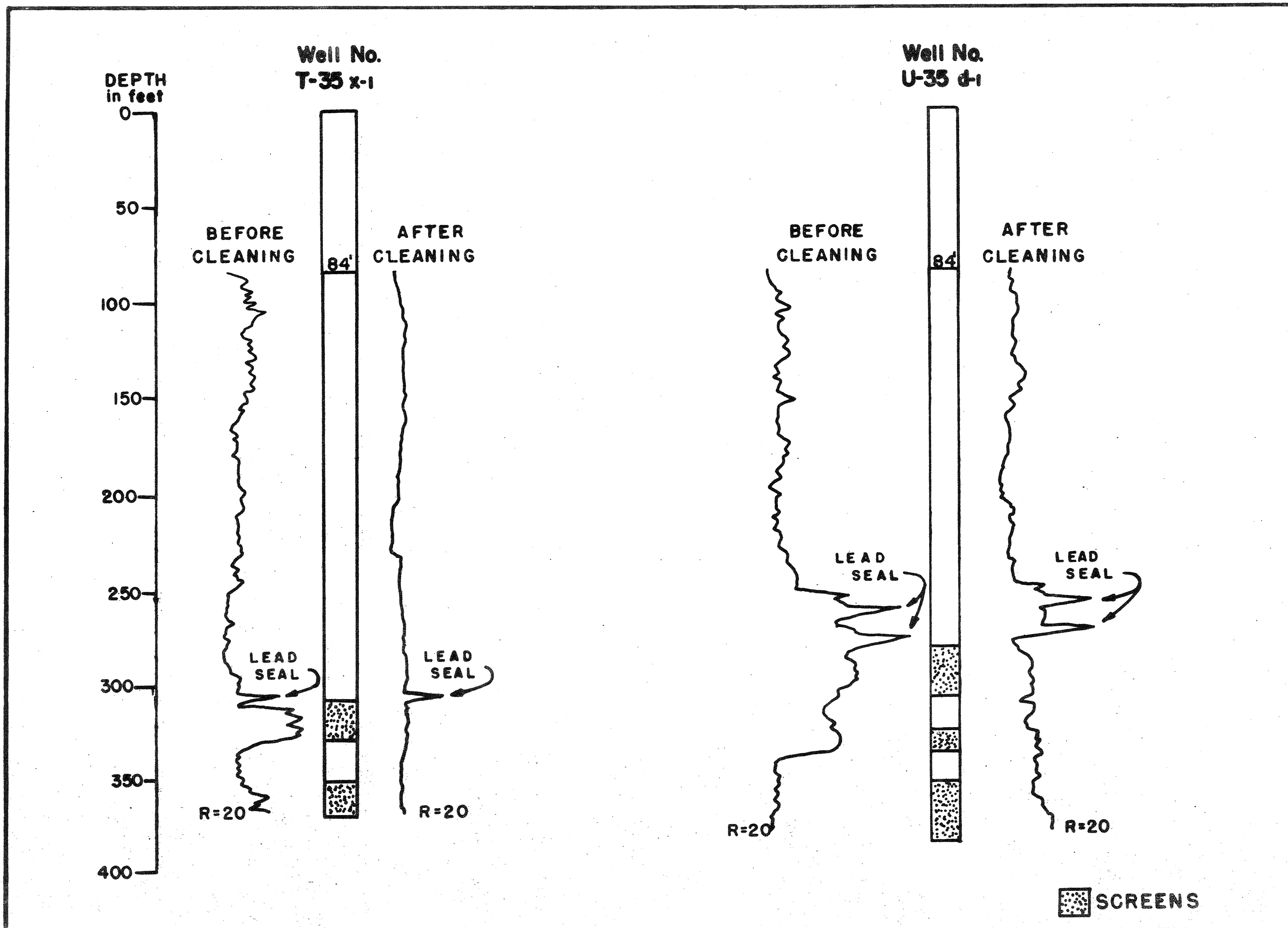

Figure 8 – Incrustation and/or corrosion of well screens as shown by electric logs.....

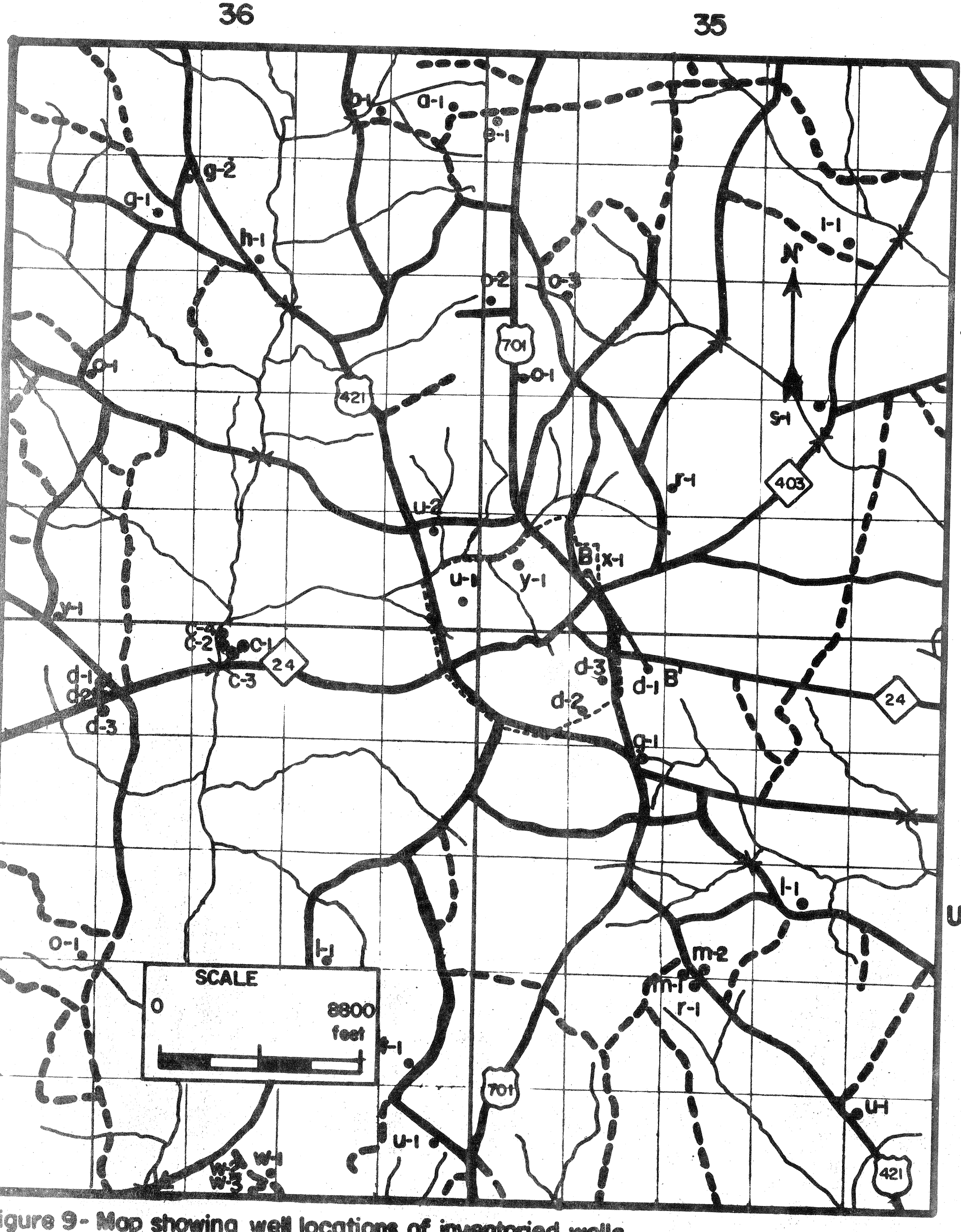

Figure 9- Map showing well locations of inventoried wells.....

TABLE I. - Records and Preliminary Chemical Analyses of Wells in the Area of Investigation

D = Domestic
P = Public
M = Municipal
Irr. = Irrigation
Ind. = Industrial

SSC = Surficial Sands and Clays
Kbc = Upper Cretaceous - Black Creek formation
Kt = Upper Cretaceous - Tuscaloosa formation
* = Complete comprehensive chemical analyses given in Table II

1 Quadrangle and Well Number	2 Location (Nearest Town)	3 Owner	4 Driller	5 Date Drilled	6 Depth of Well	7 Casing: Depth (feet)	Casing: Diameter (in.)	8 Yield	9 Use	10 Water Bearing Formation	Measuring Point (MP): 11 Description	12 Height above land surface (feet)	13 Altitude (feet above MSL)	Water Level: 14 Feet below or above (+) MP	15 Date Measured	Water Quality (Field Determinations): 16 Temperature (degrees F)	17 pH	18 Spec. conductance (micromhos at 25°C)	19 Iron (Fe) (parts per million)	20 Hardness (as CaCO3 in ppm)	21 Chloride (ppm)	22 Date Sample Collected	23 Remarks
T-35, e-1	Clinton........	R. Denton......	W. L. Best.....	1962	....	...	2	.....	D	SSC	top of casing	1	...	12	5-15-64	...	5.5	55	0.31	34	16	5-15-64	
T-35, i-1	...do..........	W. Turner......	Cannady........	1961	90	...	24	.....	D	SSC and Kbc	...do........	1.3	...	15	7-29-64	69.8	5.1	55	0.88	17	20	7-29-64	H_2S odor
T-35, o-1	...do..........	H. Starlings...	...do..........	1958	25	25	24	.....	D	SSC	...do........	0	...	7.5	5-27-64	...	...	....	....	...	...	....	
T-35, o-2	...do..........	R. L. Harris...	...do..........	1960	24	24	24	.....	D	SSC	...do........	1	...	8.5	5-27-64	...	...	....	....	...	...	....	
T-35, o-3	...do..........	Mrs. K. Herring	....	1930	19	19	..	.....	D	SSC	...do........	4.4	...	11.4	5-27-64	...	...	....	....	...	...	....	
T-35, r-1	...do..........	D. Sutton......	Cannady........	1963	37	37	24	.....	D	SSC	...do........	1.3	...	10.2	5-27-64	...	....	....	....	...	...	....	
T-35, s-1	...do..........	S. Pierce......	...do..........	1964	30	30	24	.....	D	SSC	...do........	0.9	...	7.8	7-29-64	...	...	....	....	...	...	....	
* T-35, x-1	...do..........	Town of Clinton	C. C. Hildebrand	1959	366	310	10	380	M	Kt	...do........	1	157	79	3-15-64	66	7.8	314	0.0	74	11	5-23-62	
T-35, y-1	...do..........	H. Vann........	R. O. Heater...	1955	380	...	24-8	.....	Irr	Kbc and Kt	...do........	1.5	...	20.8	7-29-64	66	7.8	314	0.1	74	11	5-23-62	
T-36, a-1	...do..........	J. H. McCullen.	I. Bracker.....	1952	50	40	2	.....	D	Kbc	....	...	...	....	....	...	...	....	....	...	...	....	
T-36, b-1	...do..........	L. D. Herring..	....	....	50	50	1½	.....	D	Kbc	....	...	...	....	....	...	6.1	70	0.03	34	14	5-15-64	Flows 2 to 3 gpm
T-36, g-1	Kitty Fork.....	J. F. Ellis....	R. O. Heater...	1955	242	242	10	200	Irr	Kbc and Kt	top of casing	...	...	41	1955	...	5.2	50	0.43	17	18	5-15-64	
T-36, g-2	...do..........	B. H. Ellis....	...do..........	1945	71	71	4	4	D	Kbc	...do........	0	...	30	5-15-64	...	5.3	50	4.9	17	14	5-15-64	H_2S odor
T-36, h-1	Clinton........	D. Johnson.....	Cannady........	1961	42	42	24	5	D	SSC	...do........	1.8	...	10	5-16-64	...	4.5	80	0.05	17	30	5-15-64	
T-36, o-1	...do..........	R. F. Butler...	....	....	16	...	24	.....	D	SSC	...do........	1	...	12.8	5-15-64	...	4.7	90	0.04	17	36	5-15-64	
* T-36, u-1	...do..........	Town of Clinton	R. O. Heater...	1955	435	385	10	560	M	Kbc and Kt	....	...	...	....	....	63	4.3	133	5.9	19	15	4-14-58	Abandoned excessive Fe
T-36, u-2	...do..........	N. C. Highway Commission...	....	....	115	...	6	.....	D	Kbc	top of casing	1	...	20.2	6-9-64	...	...	....	....	...	...	....	
T-36, y-1	...do..........	H. Boney.......	Cannady.......	....	32	24	2½	.....	D	SSC	...do........	0	...	7	5-15-64	...	5.4	60	0.25	17	22	5-15-64	
* U-35, d-1	...do..........	Town of Clinton	C. C. Hildebrand	1959	386	279	10	240	M	Kt	...do.........	1	157	77	2-20-64	64	7.5	207	2.26	64	5.4	5-23-62	
* U-35, d-2	...do..........	...do..........	...do..........	1960	410	268	10	620	M	Kt	...do........	1	157	80	12-64	66	7.6	260	0.06	74	7.7	5-23-62	
U-35, d-3	...do..........	Lundy Packing Co	Hartsfield.....	1964	415	200	10	600	Ind	Kt	...do........	2	156	80	5-27-64	...	...	....	....	...	...	....	
* U-35, g-1	...do..........	Tar Heel Motel.	C.C. Hildebrand	1959	413	384	6	300	P	Kt	....	...	...	...	....	68	...	....	....	...	...	....	Yield estimated
U-35, l-1	...do..........	R. H. Hair.....	....	1960	27	27	24	.....	D	SSC	top of casing	0	...	7.2	7-29-64	...	...	....	....	...	...	....	
U-35, m-1	...do..........	Mrs. V.K. Keenan	Cannady........	....	....	...	24	.....	D	SSC	...do........	1.3	...	11.7	7-29-64	...	...	....	....	...	...	....	
U-35, m-2	...do..........	...do..........	....	....	....	...	30	.....	D	Kbc	...do........	0	...	7.5	7-29-64	68	5.5	140	0.34	34	24	7-29-64	
U-35, r-1	...do..........	...do..........	....	....	60	...	2	.....	D	Kbc	....	...	...	....	....	63	5.5	65	1.18	17	16	7-29-64	
U-35, u-1	...do..........	P. S. Bright....	Cannady........	1962	30	30	24	.....	D	SSC	top of casing	0	...	5.4	7-29-64	...	...	....	....	...	...	....	
U-36, c-1	...do..........	J. C. Griffin..	...do..........	1958	60	60	24	.....	D	SSC	...do........	2	100	12.5	7-29-64	...	...	....	....	...	...	....	
U-36, c-2	...do..........	...do..........	....	....	26	...	2	.....	D	Kbc	....	...	90	....	7-29-64	64	5.3	70	0.25	17	14	7-29-64	Flows about 2 gpm
U-36, c-3	...do..........	...do..........	....	....	....	...	2	.....	D	Kbc	....	...	90	....	7-29-64	64	5.4	70	0.28	17	14	7-29-64	Flows about 2 gpm
U-36, c-4	...do..........	Coharie Co. Club	....	....	....	...	2	.....	D	Kbc	....	...	90	....	7-29-64	64	5.9	75	0.46	17	16	7-29-64	Flows about 2 gpm
U-36, d-1	...do..........	R.L. Faircloth.	Cannady........	1964	24	24	24	.....	D	SSC	top of casing	1	...	15.6	....	68	4.7	500	0.19	51	130	7-29-64	
U-36, d-2	...do..........	...do..........	....	1940's	27	27	24	.....	D	SSC	...do........	1	...	14.8	7-29-64	66	5.6	100	0.32	17	44	7-29-64	
U-36, d-3	...do..........	A. Cannady.....	Cannady........	1960	30	30	24	.....	D	SSC	...do........	1.4	...	12.9	7-29-64	...	...	....	....	...	...	....	
U-36, l-1	...do..........	N.C. State Forestry.....	...do..........	1961	26	26	24	.....	D	SSC	...do.........	2	...	15	5-27-64	...	...	....	....	...	...	....	
U-36, o-1	...do..........	R.J. Robertson	...do..........	1963	18	18	24	.....	D	SSC	...do.........	0	...	8.5	5-27-64	...	...	....	....	...	...	....	
U-36, u-1	Butler X-Roads.	J. B. Pope.....	...do..........	1955	52	...	2	.....	D	SSC	....	...	...	....	....	...	...	....	....	...	...	....	
U-36, t-1	...do..........	W. Gurkin......	....	....	22	...	2	.....	D	SSC	top of casing	0	...	12.5	5-27-64	...	3.9	....	0.05	51	0	5-27-64	
U-36, w-1	...do..........	D. Underwood...	....	....	26	26	24	.....	D	SSC	...do........	1	...	6.8	5-27-64	...	...	....	....	...	...	....	
U-36, w-2	...do..........	...do..........	....	....	30	30	24	.....	D	SSC	...do........	1.1	...	9.7	5-27-64	...	...	....	....	...	...	....	
U-36, w-3	...do..........	...do..........	....	....	21	21	24	.....	D	SSC	...do........	1	...	5.8	5-27-64	...	...	....	....	...	...	....	

TABLE II. - Comprehensive Chemical Analyses of Selected Wells

(Parts Per Million)

Well No.	T-35,x-1	T-36,u-1	U-35,d-1	U-35,d-2	U-35,g-1
Silica (SiO_2)	12.0	16	25	16	---
Iron (Fe)	0.0	5.9	0.26	0.06	0.12
Calcium (Ca)	13	2.8	17	14	13
Sodium (Na)	31	8.7	13	22	22
Potassium (K)	16	3.0	8.1	4.9	11
Bicarbonate (HCO_3)	172	0	115	145	145
Sulfate (SO_4)	4.6	29	4.0	5.6	---
Chloride (Cl)	11	15	5.4	7.7	7.4
Floride (F)	0.1	0.1	0.1	0.2	---
Nitrate (NO_3)	0.1	0.4	0.0	0.2	---
Phosphate (PO_4)	0.1	0.0	1.3	0.6	---
Dissolved Solids	183	81	136	152	---
Hardness as $CaCO_3$	74	0	64	74	76
Total	74	19	64	74	76
Noncarbonate	0	19	0	0	0
Specific Conductance (micromhos at 25°C)	314	133	207	260	250
pH	7.8	4.3	7.5	7.6	8.2
Color (Jackson Units)	7	0	5	5	---
Temperature (degrees F)	66	63	---	66	68
Date of Collection	5-23-62	4-14-58	5-23-62	5-23-62	8-21-59

Analysis by U. S. Geological Survey, Water Quality Branch.

R E F E R E N C E S

1. __________, 1955, The corrosion and incrustation of well screens: Edward E. Johnson Practical Information Bull. No. 834, p. 7.

2. Pusey, Richard B., 1960, Geology and ground water in the Goldsboro area: North Carolina Dept. of Water Resources, Div. of Ground Water Bull. No. 2, p. 44-56.

3. Todd, David K., 1960, Ground water hydrology: New York, John Wiley and Sons, Inc.