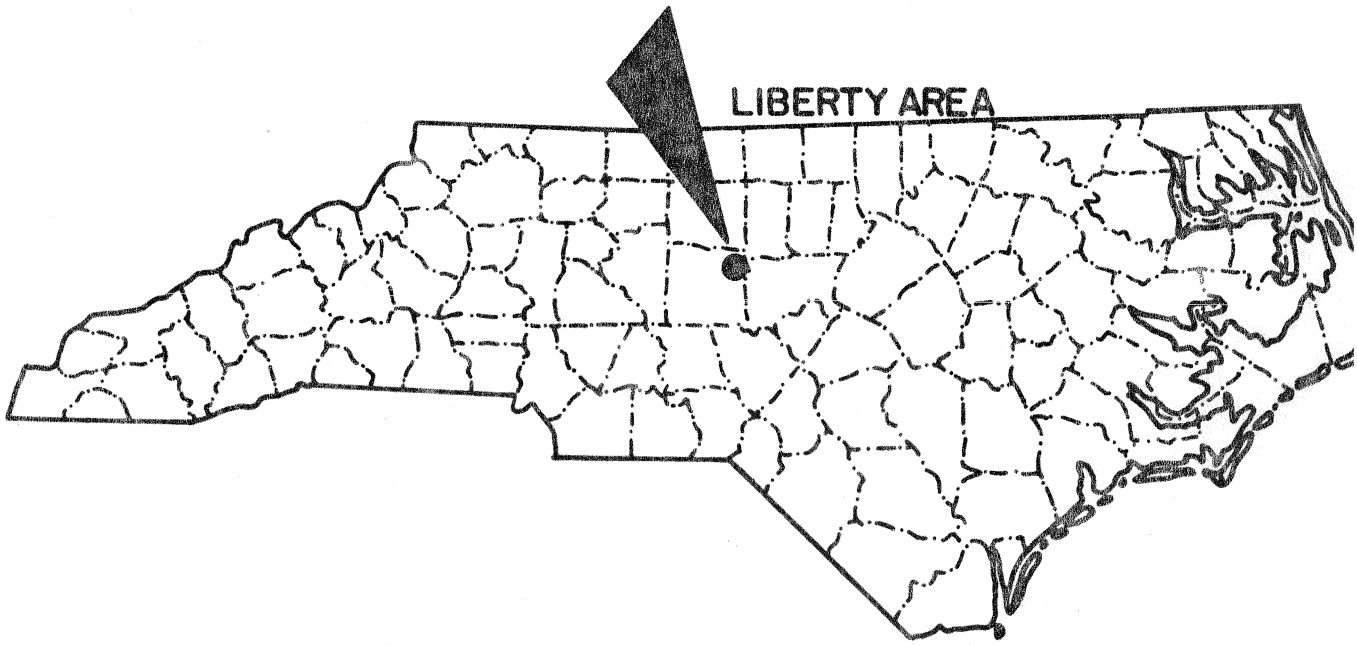
GROUND WATER CONDITIONS IN THE LIBERTY AREA RANDOLPH COUNTY, NORTH CAROLINA

GROUND-WATER CIRCULAR NO. 8



DIVISION OF GROUND WATER
NORTH CAROLINA
DEPARTMENT OF WATER RESOURCES
1965

GROUND-WATER CONDITIONS IN THE LIBERTY AREA, RANDOLPH COUNTY, NORTH CAROLINA

by

Edward L. Berry

Ground-Water Circular No. 8

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

DIVISION OF GROUND WATER
Harry M. Peek, Chief

Raleigh

1965

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By Edward L. Berry

INTRODUCTION

As a part of long-range planning, officials of the Town of Liberty requested the Division of Ground Water to appraise their existing water supply and recommend possible action for expanding the supply to meet their growing industrial and domestic water needs. Based upon this request, a brief investigation of ground-water resources in Liberty was conducted in the spring of 1964. This report summarizes the results of the investigation and offers recommendations regarding present and future development of Liberty's municipal ground-water supply.

GEOGRAPHIC SETTING

The Town of Liberty, known in 1865 as Liberty Oak while Generals Johnston and Sherman were negotiationg at the Bennett House, was incorporated in 1889. The first municipal water supply was established in 1926 and 1927. Since that time, the population has nearly doubled and, in 1964, there were about 1500 people and 25 industries in and around Liberty using the municipal water supply.

Liberty occupies about three square miles in the northeastern corner of Randolph County, (Fiqure 1) which is near the center of

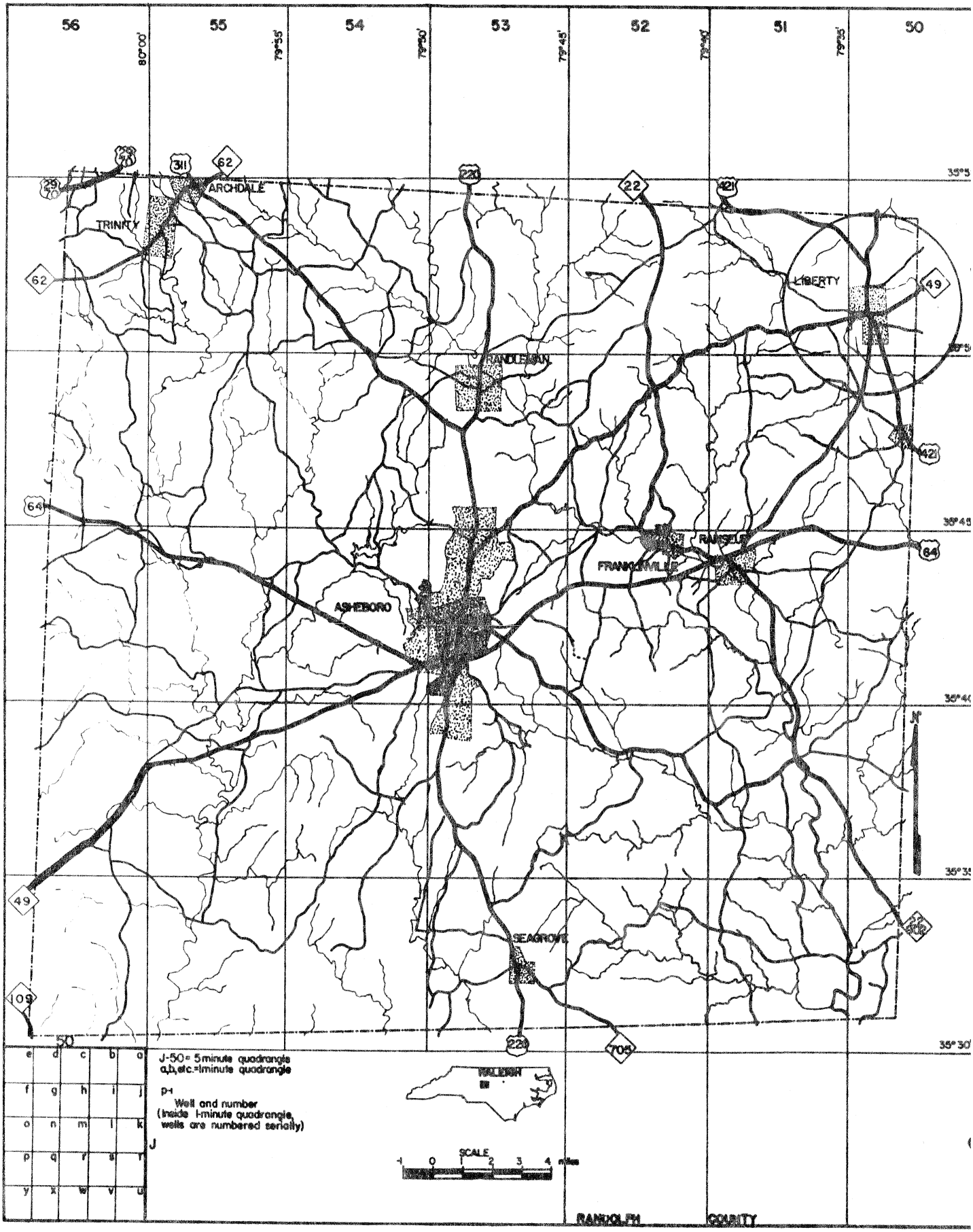

Figure 1 - RANDOLPH COUNTY SHOWING LIBERTY AREA

North Carolina'a Piedmont plateau. This area is topographically characterized by rolling, rounded hills and flat valleys with a few sharp draws containing streams and ponds. The maximum relief is about 100 feet, with elevations ranging from 700 feet above sea level in the stream valleys on the outskirts of town to about 800 feet above sea level near the center of town. The Liberty area is in the Cape Fear River Basin and the area is locally drained by Sandy Creek and Rocky River tributaries which flow into the Cape Fear via Deep River.

The climate of Liberty is indicated by records from three U. S. Weather Bureau stations at Asheboro, Randleman and Siler City forming a triangle containing the town. All of these stations record pricipitation, but only two maintain temperature records. No measurements have been made on soil moisture content and soil temperature. The oldest weather station at Randleman has records dating from 1910 to the present, while the youngest station at Siler City has records of precipitation since 1937. The following Table I gives normal monthly and annual precipitation figures at each station along with averages of all three stations through December 1963.

The average annual precipitation of these three stations is 46.20 inches with July being the wettest month with an average of 5.43 inches, and October being the driest month with an average of 2.80 inches. The highest recorded annual precipitation in the area was 64.92 inches at Randleman in 1936, and the lowest was at Asheboro in 1933 and 1941, when only 27.90 inches of precipitation was recorded.

TABLE 1 - Precipitation

Station	Elev. in Feet	Years of record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Asheboro	870	33	3.66	3.57	4.14	3.61	3.57	3.88	5.32	4.76	3.63	2.72	2.86	3.42	45.15
Randleman	810	54	3.73	3.79	3.98	3.56	3.84	4.05	5.59	4.94	3.70	2.72	2.65	3.62	46.17
Siler City	625	27	3.74	3.78	4.18	3.36	3.67	4.12	5.37	4.76	4.12	2.95	3.48	3.40	47.23
Average			3.71	3.72	4.10	3.61	3.69	4.02	5.43	4.82	3.82	2.80	3.00	3.48	46.20

Only the Asheboro and Siler City weather stations recorded temperatures in the immediate vicinity of Liberty. The average mean annual temperature at these two stations is slightly over 60° F (Fahrenheit). December is the coldest month with an average temperature of 43.5° and July is the warmest month with an average temperature of 78.4° F.

GEOLOGY

The geology of Liberty, typical of North Carolina's Piedmont region, is complex and includes several types of crystalline rocks. The exposed metamorphic and igneous rocks are predominantly the felsic volcanics of the Carolina slate belt but include gabbro and numerous veins of secondary quartz. They generally trend northeast and appear to dip gently toward the southeast in the vicinity of Liberty. Although there were several types of tuff, both felsic and mafic, no attempt was made to separate them in this study. Generally, the contacts between the tuff and slate formations appear to be gradational, both horizontally and vertically. The gabbro is apparently a massive intrusion that crops out just southeast of the town's center (Figure 2). It is composed chiefly of feldspar, pyroxene and green hornblende which has weathered to epidote. The gabbro is a medium grained, hard, dense, massive rock, referred to as green granite by well drillers in the Liberty area. Except for gabbro, the rocks are highly fractured and jointed with veins of secondary quartz cropping out in several places. In many

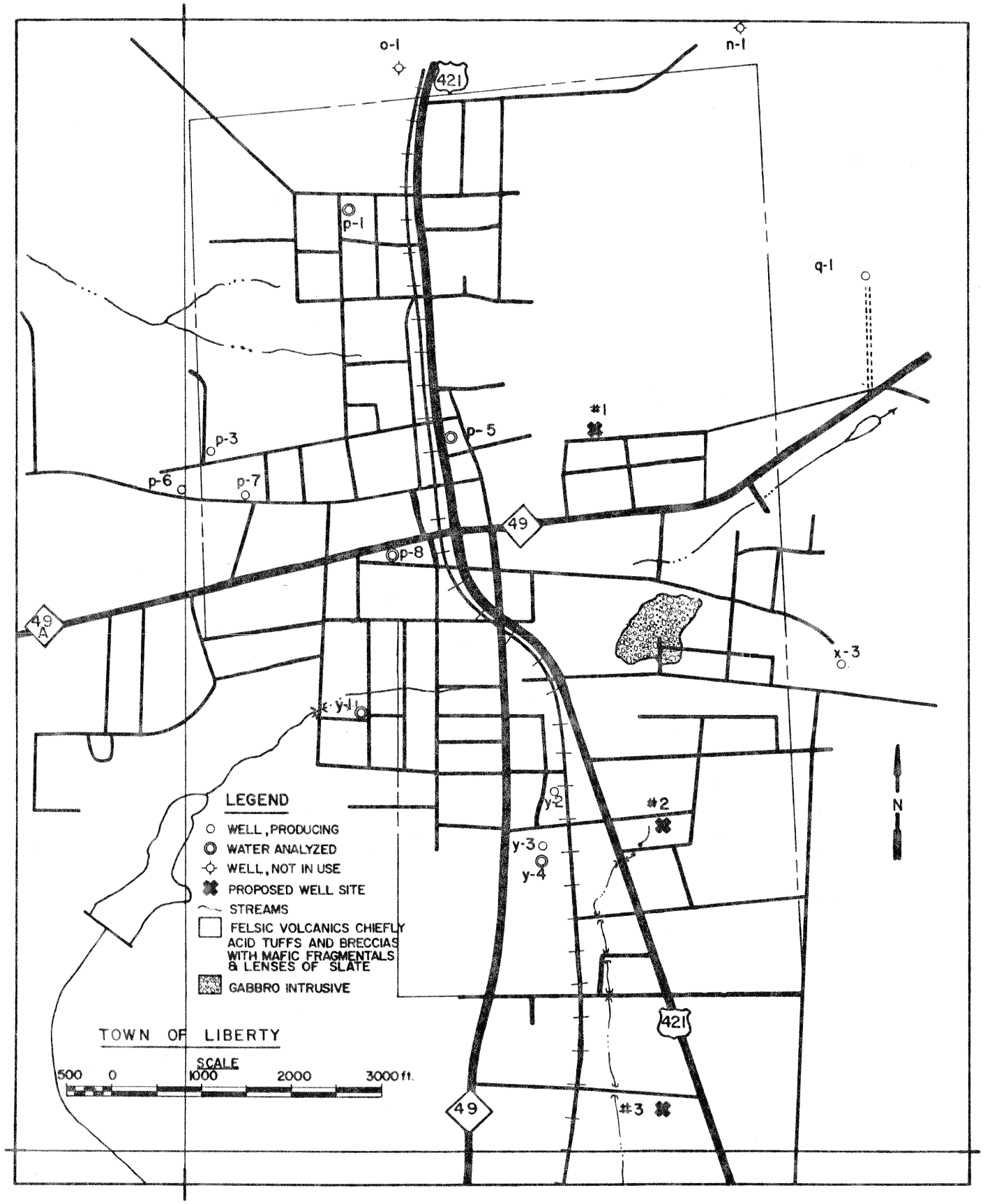

Figure 2 - LOCATIONS OF PROPOSED DRILLING SITES AND SELECTED WELLS IN THE LIBERTY AREA, RANDOLPH COUNTY, NORTH CAROL

other places angular quartz gravel indicates that almost the entire area is "honeycombed" with quartz veins. Both the quartz and the gabbro tend to form ridges. The ridges underlain by quartz appear to be orientated radially and concentrically around the gabbro. The soil mantle overlying the rocks in Liberty is a cecil clay and fine sandy loam (Hardison and Perkins, 1915, Soil Map) ranging in thickness from 0 to more than 8 feet before grading into weathered rock. Except in the outcrop area of the gabbro, weathering of the rocks probably extends to considerable depths, as some of the drilled wells are cased to a depth of 90 feet or more.

GROUND WATER AND HYDROLOGY

Practically all our usable surface and subsurface water ultimately comes from the oceans where the sun and air extract water vapor that is then transported inland by winds and precipitated as rain, that again moves back towards the oceans. This is a brief summary of our hydrologic cycle that is continuously being repeated (Figure 3). Once on land the water vapor may also be extracted from streams and other bodies of fresh surface water and from the soil. Great quantities of water are also returned to the atmosphere by transpiration of plants. During periods of precipitation a part of the water returns to the atmosphere via evapotranspiration; part of the rain enters streams and ponds as surface runoff and part of the rain soaks into the earth to become ground water that maintains streams and vegetation during dry periods.

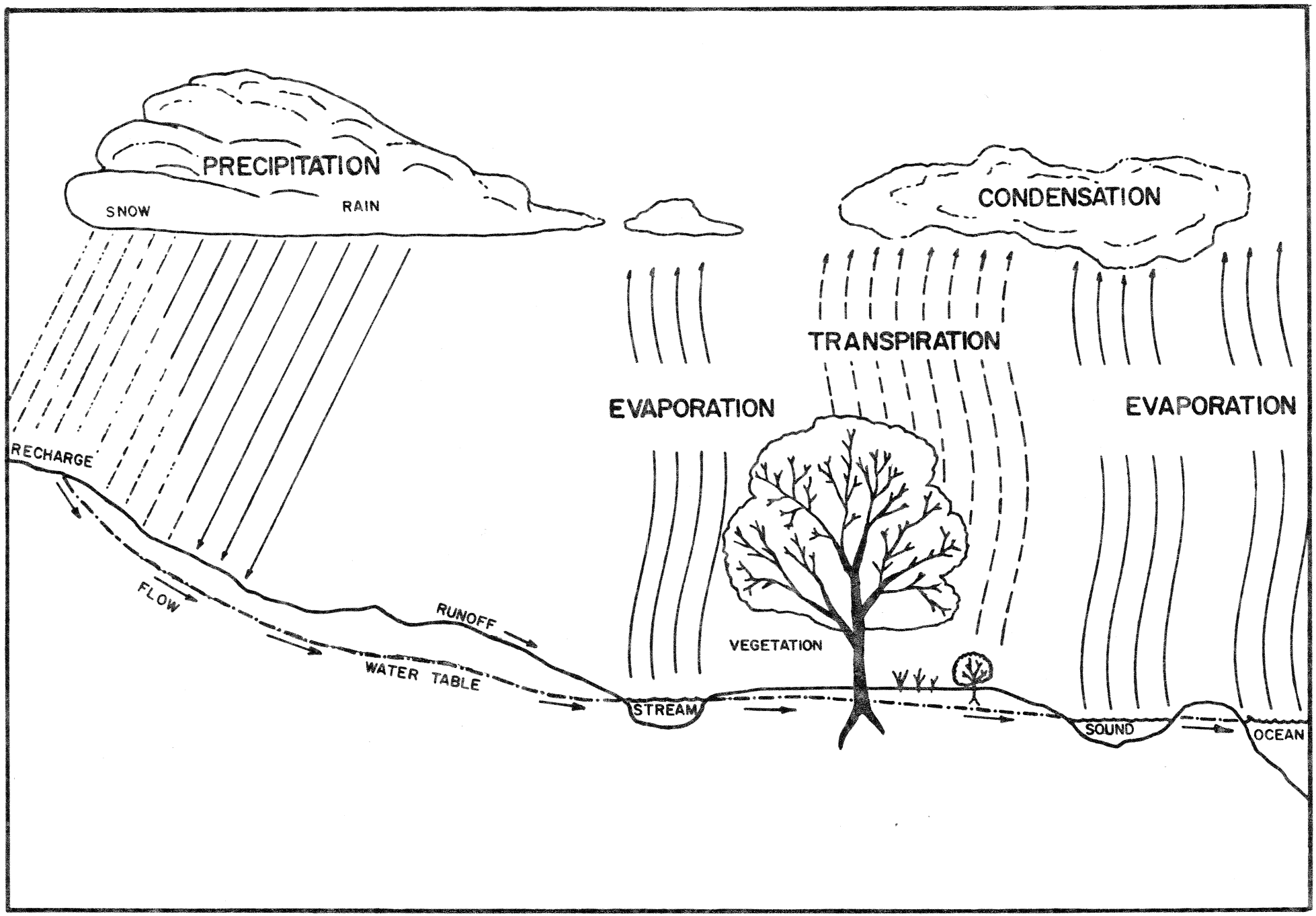

Figure 3 - The Hydrologic Cycle

Meinzer (1942, p. 401) estimates that about one-third of the annual precipitation is available for ground-water recharge in North Carolina. Based on this figure, over four and one-half billion gallons per year become available within a radius of three miles from the center of Liberty. This indicates an abundance of ground water in the Liberty area.

In the Liberty area, ground water occus both in the soil zone, weathered rock zone and in fractured bedrock (Figure 4). In the soil and weathered rock zones ground water is stored in voids between individual mineral grains, rock fragments and remnant structural features. Lack of thickness and permeability generally limit the quantity of water that can be extracted from these zones; however, they serve as storage reservoir for recharge to the underlying bedrock. Only domestic water supplies are obtained from wells dug or bored into the zone of weathered rock.

In the crystalline bedrock, composed principally of tuff, slate and gabbro, water occurs in the structural openings such as joints, faults, bedding plans and similar voids. The availability of water from this reservoir generally depends on the number, size and inter-connection of the openings. These rock fractures usually decrease with depth so that most of the water in the bedrock reservoir occurs in the upper several hundred feet of bedrock. The abundance of quartz dikes in the vicinity of Liberty and productivity of the existing wells indicate the presence of many interconnecting fractures, thus, with careful selection of well sites, ground water in relatively large quantities can probably be obtained.

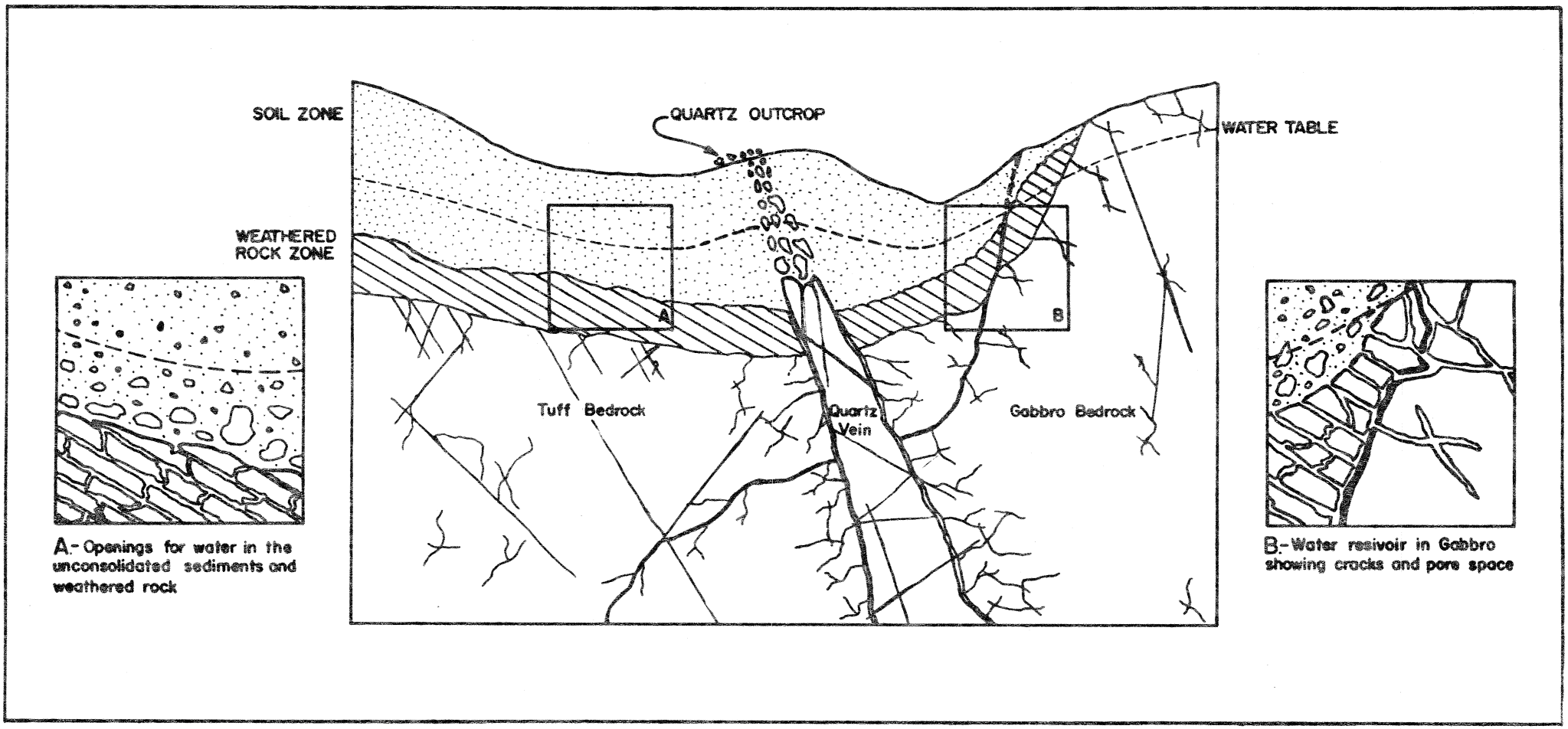

Figure 4 - DIAGRAMMATIC CROSS SECTION SHOWING WATER TABLE & GROUND WATER RESERVOIR

QUALITY OF WATER

Water from rainfall and other precipitation from the atmosphere contains only small amounts of dissolved minerals, but, after reaching the earths surface, it dissolves minerals from the soils and rocks over and through which it passes. The principal factors that determine the quality of ground water are the amount and composition of material in the soil zone, the mineral composition of the rock, the time the water is in contact with the soil and rock, the acidity (pH) and the temperature of the water.

Partial analysis of water from Liberty's municipal wells suggest no quality problems. The water contains an average of 0.11 ppm (parts per million) iron, 67 ppm total hardness, and slightly over 100 ppm of total dissolved solids. The water has an average temperature of 61.1° F and a pH of 7.5.

There are very few private wells in Liberty as the municipal supply has been in existence so long; however, the few available well records indicate that domestic water supplies are available almost everywhere from the weathered rock and soil zones, with moderate to large quantities of water available from the bedrock reservoir. Table II contains the results of a well inventory made at Liberty.

PUMPING TESTS

As a part of the study, step-drawdown pumping tests were attempted on four of the Town's five supply wells to determine the

TABLE 2 - Records and Preliminary Chemical Analyses of Wells in the Area of Investigation

D = Domestic
M = Municipal
B = Bucket
T = Turbine Pump
H = Hand Pump

Xyln = Crystalline
OH = Open Hole
RK = Rock Lined
S = Submersible Pump

Grid Location and Well Number	Nearest Town	Owner	Driller	Date Completed	Depth of Well (feet)	Construction: Casing: Depth (feet)	Construction: Casing: Diameter (inches)	Construction: Finish: Open hole or screen	Construction: Finish: Slot Size	Use of Water	Method of lift	Aquifer: Rock Type	Aquifer: Age & Formation	Aquifer: Depth to water-bearing zone	Aquifer: Yield (gpm)	Measuring Point (MP): Description	Measuring Point (MP): Height above land surface (feet)	Measuring Point (MP): Altitude (feet above MSL)	Water Level: Depth (feet) below M.P.	Water Level: Date of measurement	Water Quality Field Determinations: Temperature (degrees F)	Water Quality Field Determinations: Hardness ($CaCO_3$)	Water Quality Field Determinations: pH	Water Quality Field Determinations: Specific conductance	Water Quality Field Determinations: Date of Analysis	Remarks
J-50, n-1	Liberty.....	.....	.....	.....	60	?	6	OH	....	.....	...	Xyln	FC or EC	59	8-10	Top of casing.	0.40	.....	30	5-1964	61	.....	.....	.....	.....	.....
J-50, o-1	...do.....	Hoit Henshaw...	Hand dug.....	.....	32	32	30	RK	....	D	B	Soil	..do..	22	3	Edge well house	2.50	.....	26.5	5-1964	....	.....	.....	.....	.....	.....
J-50, p-1	...do.....	Town of Liberty	R.E. Faw & Sons	8-1951	397	78	8	OH	....	M	T	Xyln	..do..	....	70?	Edge of casing in elect box	1.80	.....	27.45	5-1964	60.4	60	7.0	140	5-26-64	Lib. Well 4
J-50, p-3	...do.....	Francis Smith..	J.G. Faw.....	1948	63	30	6	OH	....	D	Jet	.do.	..do..	....	60	Top of casing.	0.50	.....	25.0	5-1964	....	.....	.....	.....	.....	.....
J-50, p-5	...do.....	Town of Liberty	Va. Machine & Well Co., Inc..	1926	262	...	...	OH	....	M	T	.do.	..do..	....	111	Top of casing.	2.05	.....	67.45	5-1965	61.3	80	7.8	180	5-26-64	Lib. Well 1
J-50, p-6	...do.....	J.C. Kirkman...	.....	1929	52	52	24	OH	....	D	B	Soil	..do..	40	.....	.....	....	.....	.....	.....	....	.....	.....	.....	.....	.....
J-50, p-7	...do.....	Luke Andrews...	Owner.....	.....	42	42	8	OH	....	D	B	.do.	..do..	30	.....	.....	....	.....	.....	.....	....	.....	.....	.....	.....	.....
J-50, p-8	...do.....	Town of Liberty	Va. Machine & Well Co., Inc..	1926	231	90	8	OH	....	M	T	Xyln	..do..	....	93.8	Top of casing.	2.25	.....	43.4	5-1964	61.2	45	7.5	120	5-26-64	Lib. Well 2
J-50, q-1	...do.....	....do.....	Heater Well Co.	1963	205	21	6	OH	....	M	SP	.do.	..do..	90 175-185	30	...do.....	1.00	.....	6	5-1964	60.8	.....	.....	.....	.....	Sewage Plant Well 1
J-50, x-3	...do.....	Bob Flint.....	.....	1948	154	30	3	OH	....	D	HP	.do.	..do..	150	8	...do.....	0.04	.....	15	5-1964	....	.....	.....	.....	.....	.....
J-50, y-1	...do.....	Town of Liberty	Sydnor Well & Pump Co.....	1954	600	400-600	10 6	Slot	¼"	M	T	.do.	..do..	....	.....	.....	....	.....	.....	.....	61.2	85	8.0	200	5-26-64	Lib. Well 5
J-50, y-2	...do.....	Stout Chair Co.	.....	1947	60	...	2	....	....	.....	...	.do.	..do..	....	.....	Top of casing.	0.05	.....	12	1963	....	.....	.....	.....	.....	USGS (Nr-21)
J-50, y-3	...do.....	Gregson Mfg.Co.	.....	1933	80	...	6	OH	....	.....	Jet	.do.	..do..	....	10	.....	....	.....	.....	.....	....	.....	.....	.....	.....	.....
J-50, y-4	...do.....	Town of Liberty	Va. Machine & Well Co., Inc..	1943	232	120	8	OH	....	M	T	.do.	..do..	120-125 & 150	90	Air gauge.....	180 below	.....	Pumping 160	5-1964	62.6	65	7.0	160	5-26-64	Town Well 3

yield of each in gallons per minute for each foot of drawdown, or the specific capacity. The yield of the well at any desired pumping water level can be determined with reasonable accuracy from the specific capacity.

Well J50-p8 (Town Well No. 1) is an excellent well for this area with specific capacities of 1.56 gpm/ft. dd. (gallons per minute per foot of draw down) at 111 gpm and 1.45 gpm/ft. dd. at 71 gpm. These figures are derived from the results of the step-type pumping test illustrated in figure 5-A and B. These graphs show the relationship between water levels and well yields while pumping at several constant rates. Well No. J50-p5 may be used more efficiently by setting the pump intake at a depth of about 210 feet and maintaining a pumping level of about 190 feet. This would permit a sustained yield of about 180 gpm which is more than twice the present yield of 86 gpm.

Well J50-p5 (Town Well No. 2) is also a very good well for this area with a specific capacity of 1.04 gpm/ft. dd. at 84 gpm and 1.05 gpm/ft. dd. at 73 gpm as shown in figure 6-A and B. By measuring the pumping level this well was found to deliver about 75 gpm into the system (Figure 6-C). Based on specific capacities, this well may be used more efficiently by setting the pump intake at a depth of about 220 feet and by maintaining a pumping level of about 180 feet. This would permit a sustained yield of about 140 gpm, which is nearly twice the present yield of 75 gpm.

It was not possible to accurately test Well No. J50-y4(Town Well No. 3) as water levels and yields could not be measured.

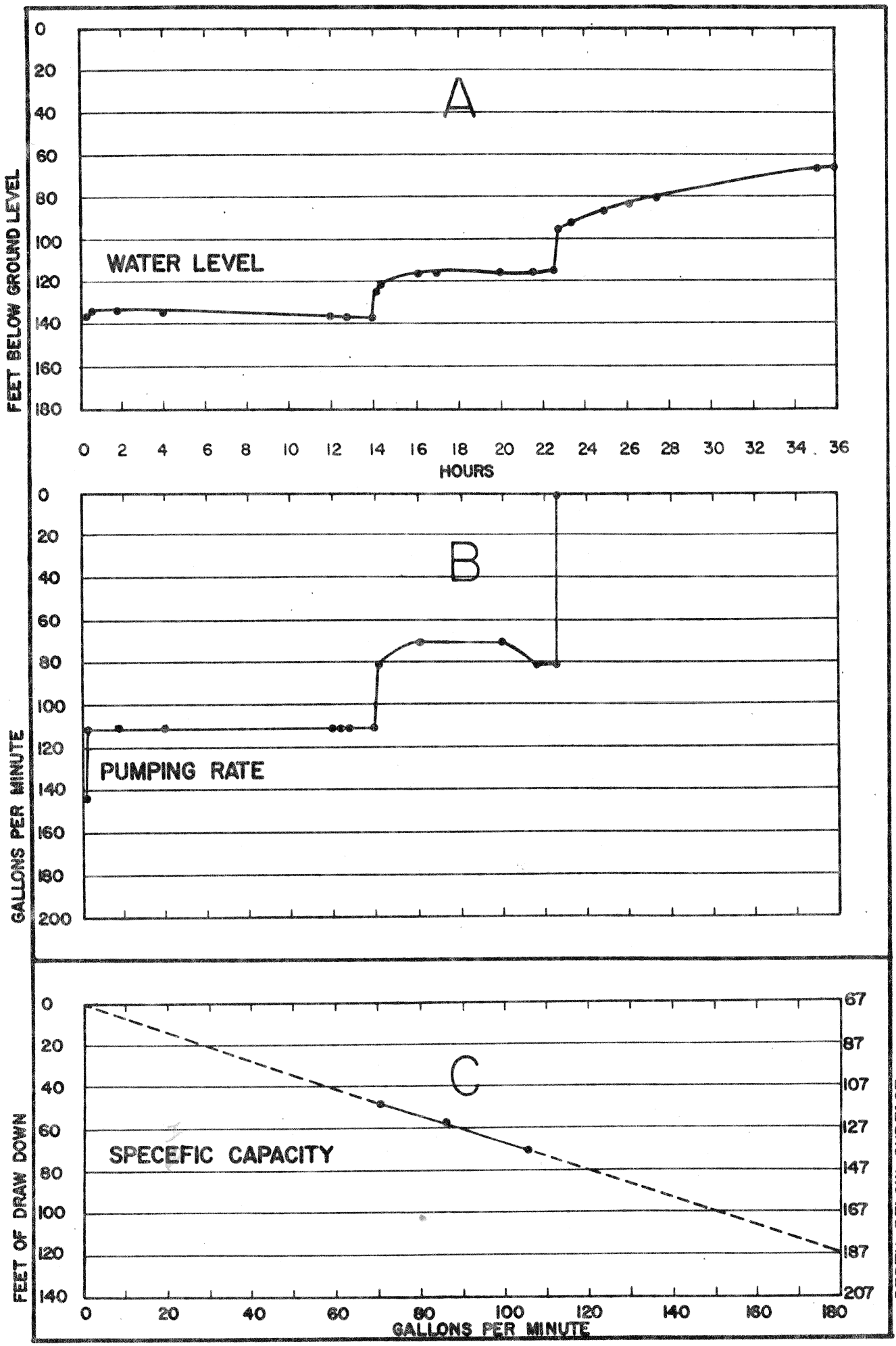

Figure 5 -Pumping Test of Well No. 1

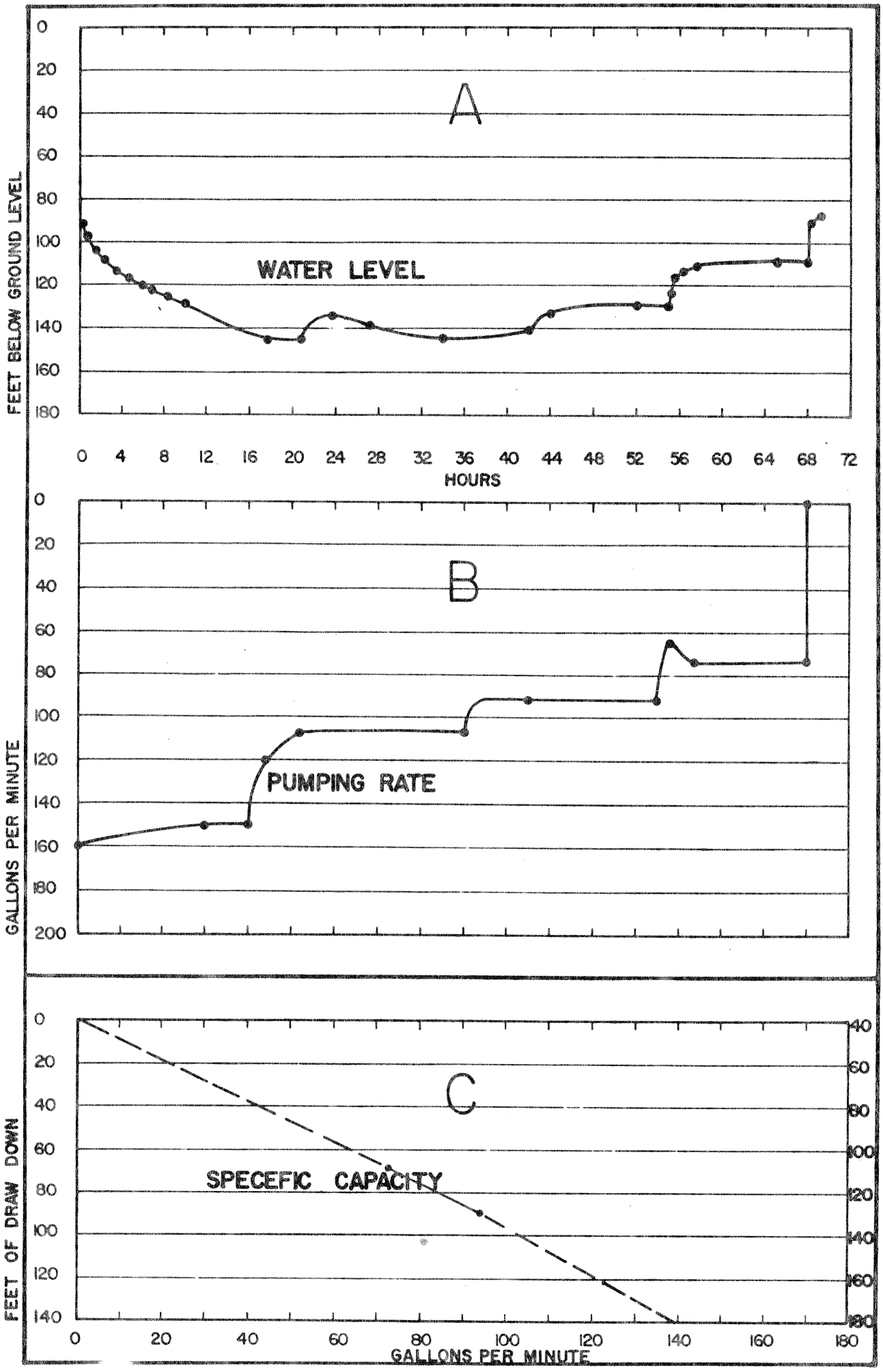

Figure 6 ...DING TEST WELL No 2

Based on information provided by town officials and others, this well is probably delivering about 70 gpm into the system. To obtain accurate data on this well, it is recommended that an opening be made into the well to allow water level measurements, and that another valve be put into the system to allow measurements of yields at the well. These steps would allow an accurate and comprehensive test of the well. Figure 7-A illustrates the assumed results from pumping into the lines.

Well No. J50-p1 (Town Well No. 4) began pumping 100 gpm and was cut back to 71 gpm at the end of one hour. Even at this lower yield the pump began to pump air after the second hour. To avoid damage to the pump the test was discontinued and a recovery was taken. The graph (Figure 7-B) on Well No. 4 shows that the well is presently being over pumped with the existing pump intake depth. Using A and B of figure 7-B, the sustained yield of Town Well 4 is estimated to be about 40 gpm with the pump intake set at a depth of 185 feet. However, by lowering the pump intake to a depth of 250 or 300 feet, a considerably higher yield may be obtained from this well.

Well P50-y1 (Town Well No. 5) is reported to be 600 feet deep; however, a bail bucket occupies the bottom 15 feet. This well was started as a 10-inch well and was cased to a depth of 400 feet at which point it was reduced to an 8-inch well. In order to prevent quick sand and gravel from entering, a 6-inch slotted casing was inserted the full depth of the well. The well was then tested and a yield of 120 gpm was reported. The well cannot be accurately

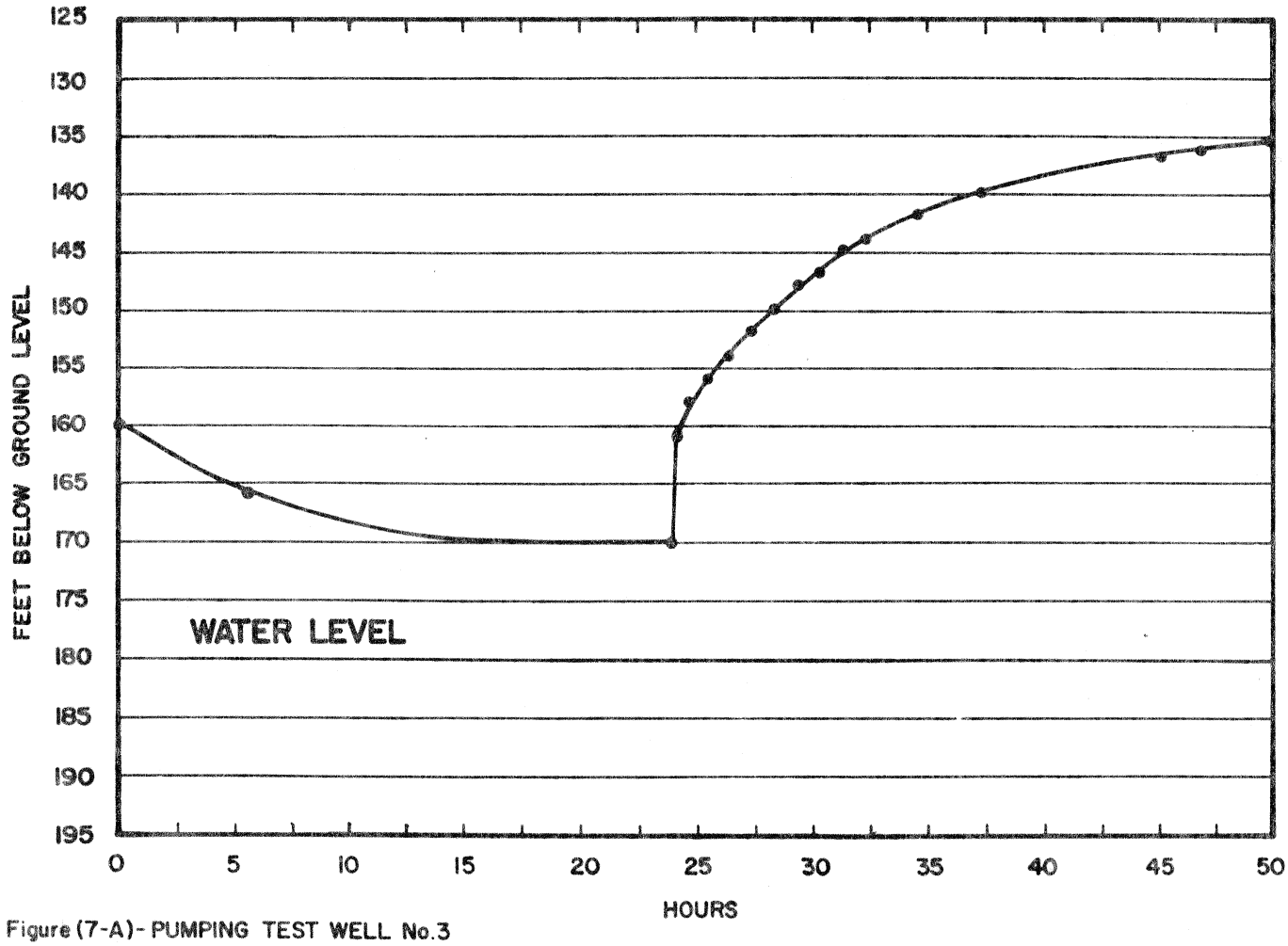

Figure (7-A)- PUMPING TEST WELL No.3

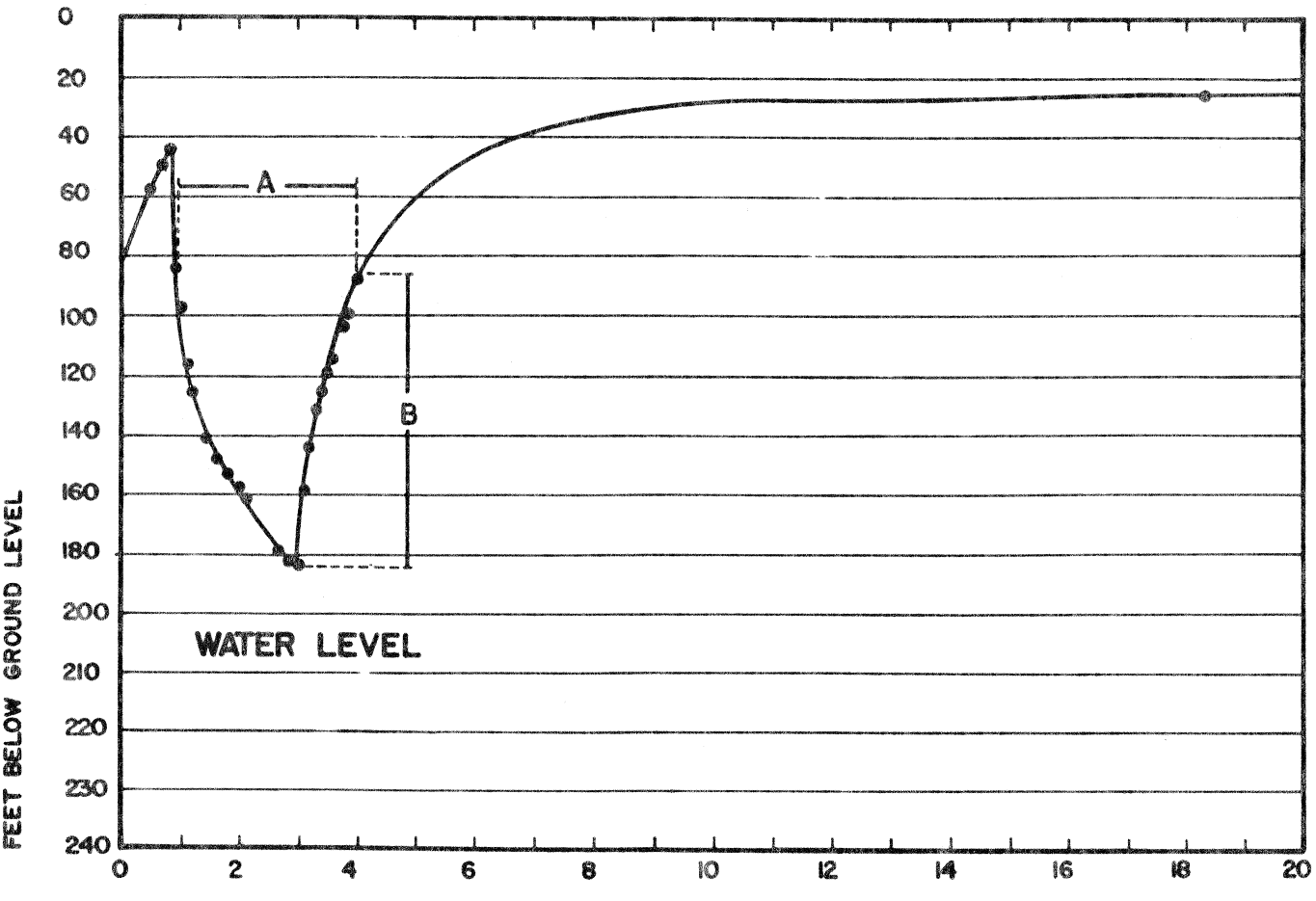

Figure (7-B) PUMPING TEST WELL No. 4

tested at the present time; but by turning on the pump, the yield was measured at 200 gpm for a period of 15 minutes at which time the yield dropped to about 100 gpm and air was being pumped although the pump intake is at a depth of 550 feet. Obviously this well is being over pumped and a smaller pump should be installed. This well is estimated to have a sustained yield of about 50 gpm. Possible improvements in the use of the well include the installation of a smaller pump that would maintain a sustained yield of 50 gpm, or reworking to try to increase the yield.

Table 3 summarizes findings from these pumping tests. The wells presently are able to yield about 460,000 gpd (gallons per day) but the potential yield is estimated at 690,000 gpd. In addition, the sewage-plant well reportedly furnishes 30 gpm and is sufficient for present plant use.

Table 3 - Yields of Municipal wells at Liberty (continuous pumping)

Well Numbers		Present Capacities		Potential Capacities	
Our Number	Liberty's Number	GPM	GPD	GPM	GPD
J50-p8	1	86	123,840	180	259,200
J50-p5	2	75	108,000	140	201,600
J50-y4	3	70 ?	100,800 ?	70 ?	100,800 ?
J50-p1	4	40 ?	57,600	40	57,600
J50-y1	5	50 ?	72,000	50	72,000
Total		321	462,240	480	691,200

SUMMARY OF WATER USE AND RECOMMENDATIONS

Estimated Consumption of Water

As all water is not metered, the exact quantity of water used by the town is not known. Based on monthly billing records (Figure 8) over the last two years, industrial and domestic customers use an average of 175,000 gallons of Liberty's water each day. As the industries are dormant over weekends, the average daily use during the week is estimated at 250,000 gallons, and maximum daily use is probably more than double this amount. It is estimated that fire control and sanitation use an additional 200,000 each day on an average. The estimated use of water is summarized in Table 4.

Table 4 - Daily Water Use in Liberty

Consumer	Min. GPD	Average GPD	Max. Demand GPD
Domestic and Business	175,000	250,000	500,000
Sanitation	75,000	100,000	*150,000
Fire Control	0	100,000	250,000
Totals	250,000	450,000	900,000

*This figure is based on the Town's new sewage plant.

Improvement of the Existing Water System

The findings of this investigation indicate that the following steps would greatly improve the existing water supply of the Town of Liberty:

1. Well No. 1 should have the pump intake set at a depth of 210 feet providing a sustained yield of about 180 gpm with the pumping level at a depth of about 190 feet.

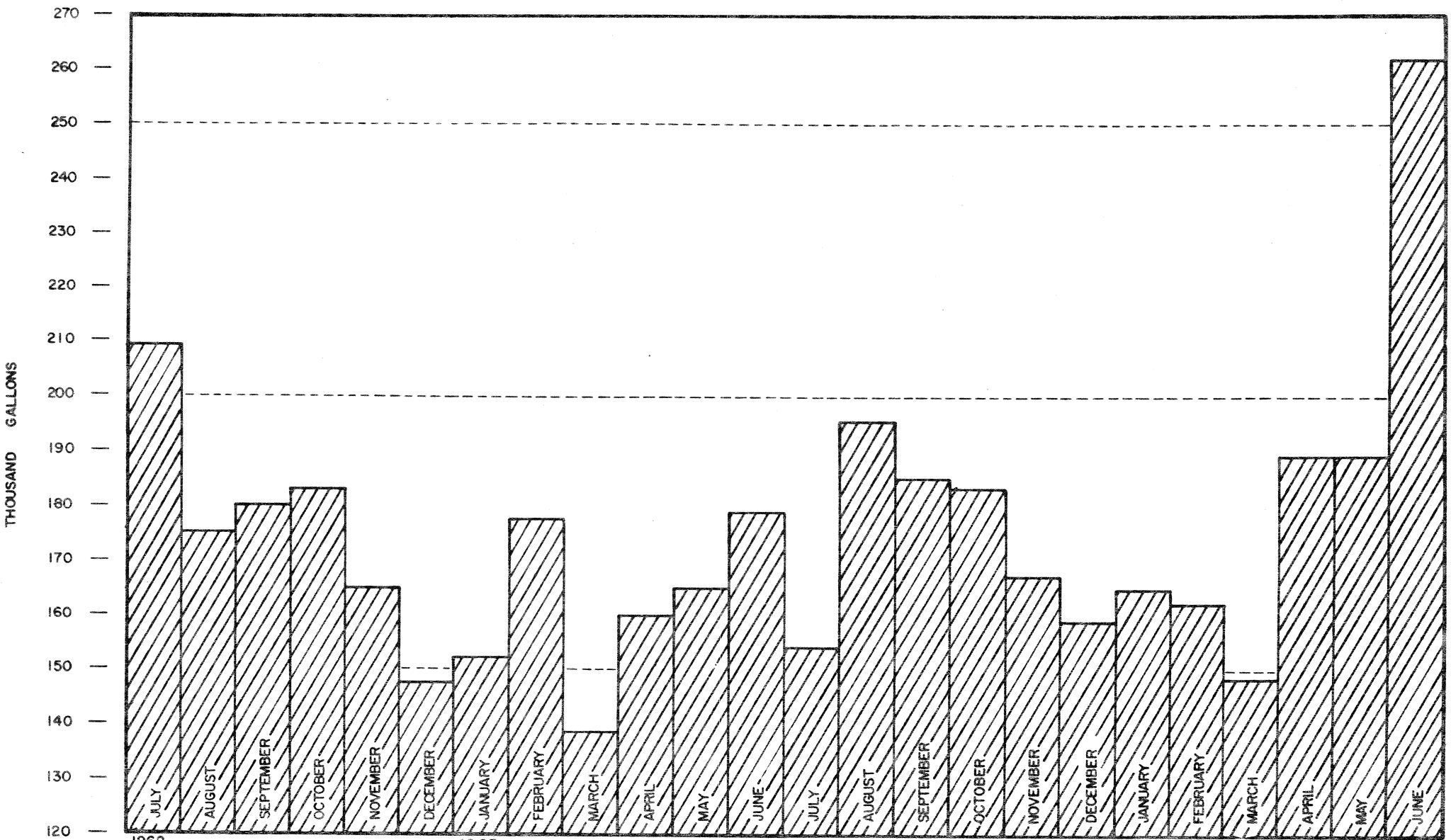

Figure 8 - USE OF GROUND WATER IN LIBERTY (BASED ON MONTHLY BILLING RECORDS)

2. Well No. 2 should have the pump intake set at a depth of 220 feet with a sustained yield of about 140 gpm with the pumping level at a depth of about 180 feet.

3. Well No. 3 should be altered to permit measurements of water levels and yields, and should then be tested for specific capacity.

4. The pumping rate should be reduced to a sustained yield of about 40 gpm on Well No. 4. An attempt should be made to lower the pump intake and then a more comprehensive pumping test should be made.

5. The pumping rate should be reduced on Well No. 5, to maintain a sustained pumping rate of about 50 gpm.

These steps should increase the Town's water supply from 450,000 gallons per day to a maximum of almost 700,000 gallons per day. They would also allow a more accurate appraisal of the present system.

Recommended Future Development

Additional wells should be drilled at favorable sites as soon as possible to determine the potential supply for future expansion. Water information and availability would encourage industrial growth and town prosperity while additional wells could also be used for possible emergencies. Favorable well sites that were selected as a part of the study are indicated on the map in figure 2 and are numbered in their order of preference.

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