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GROUNDWATER ASSESSMENT STUDY FOR 50 COMMUNITIES IN SOUTHEASTERN--ETC(U)
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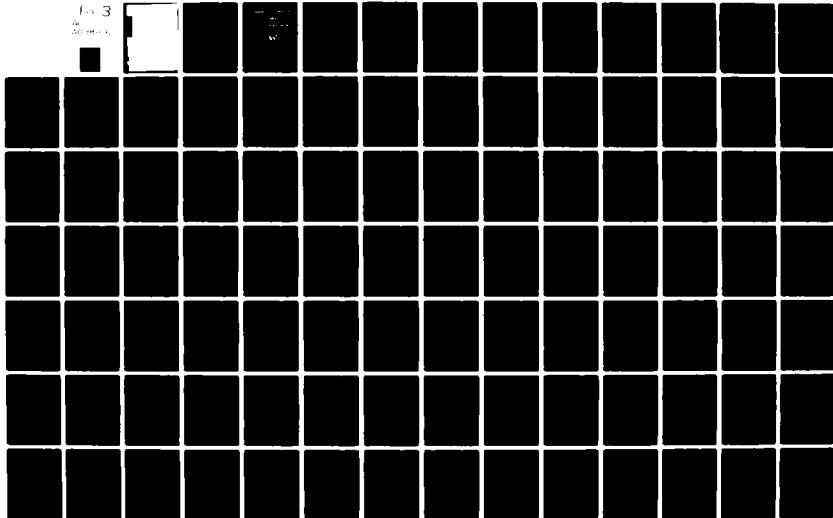
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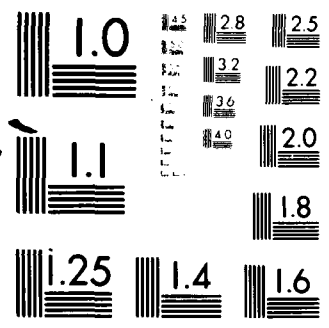
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GROUNDWATER ASSESSMENT STUDY
for
50 COMMUNITIES
in
SOUTHEASTERN NEW HAMPSHIRE



PREPARED FOR
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154
BY
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SEPTEMBER 1980

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A. BACKGROUND

Over the past decade the State of New Hampshire has experienced a rapid increase in population, industrial expansion, changes in agricultural land use and a rising level in the standard of living. This socio-economic development has been particularly prevalent in the southeastern New Hampshire area primarily due to its proximity to the Boston, Massachusetts employment area. As a result of this growth a steadily rising demand for water has been experienced which is expected to continue.

Based on the population projections in the Corps of Engineers (COE) in the Southeast New Hampshire Water Supply Study (July 1976), the estimated population served by 36 communities within the study area is expected to increase from 224,552 in 1977 to 487,178 in the year 2030. The corresponding average daily water demand of 21.09 mgd (million gallons per day) is expected to increase to 50.57 mgd in 2030. A deficit of existing supplies indicates a rise from approximately 0.11mgd and 12.24mgd by 1980, to approximately 18.9 mgd by the year 2030 for average and maximum day flows respectively.

The area presently depends on the use of groundwater as the primary method to meet the water demand, with a small number of communities such as Rochester utilizing surface water supplies. Therefore, as the need for water increases, so does the need for further information and careful planning to insure the optimal use of existing sources and the implementation of new ones. As a result of these water demand projections, the New England

Division of the Corps of Engineers (COE) has requested the consulting firm of Anderson-Nichols & Co., Inc. to conduct a groundwater assessment study for the southeastern New Hampshire area.

B. AUTHORITY

The authority for this project is derived from the House Resolution of the Committee on Public Works, dated 23 September 1976, on file in the New England Division Library.

C. SCOPE OF WORK

A Phase I study, undertaken by the firm of Hayden, Harding and Buchanan, Inc. (HHB), was conducted on 81 aquifers delineated by the COE. At the conclusion of Phase I, 53 sites were judged to warrant further investigation. The 28 sites eliminated from further investigation are included in Appendix B. A copy of the Phase I report, completed in September 1978, may be found in Appendix A.

This report of the Phase II study, endeavors to determine the quantity and quality of groundwater in those 53 aquifers identified in the Phase I study as requiring further investigation as well as to three aquifers which were added during the study at the request of State of New Hampshire officials. However, during the course of this Phase II study some of these aquifers were eliminated and others were added resulting in 61 potential aquifers being evaluated.

Estimates of potential safe sustained yields are of sufficient accuracy for use in a level "c" planning study.

The principal study tasks encompassed:

- Reviewing the initial COE draft report and collecting additional data base to allow sufficient delineation of 61 potential unconsolidated aquifers within 50 communities in southeastern New Hampshire.
- Conducting a field reconnaissance of 20 sites not visited by Corps geotechnical personnel.
- Applying engineering judgement to effectively utilize information obtained.

These tasks have formed the basis to obtain the following study objectives:

1. Develop a suitable methodology, based on existing available data, for the quantitative evaluation of the potential safe sustained yield of the 61 potential unconsolidated aquifer sites.
2. Determine the safe sustained yields for the unconsolidated aquifer sites.
3. Provide conclusions and recommendations as to the relative value of more detailed investigations and development at the aquifer sites.

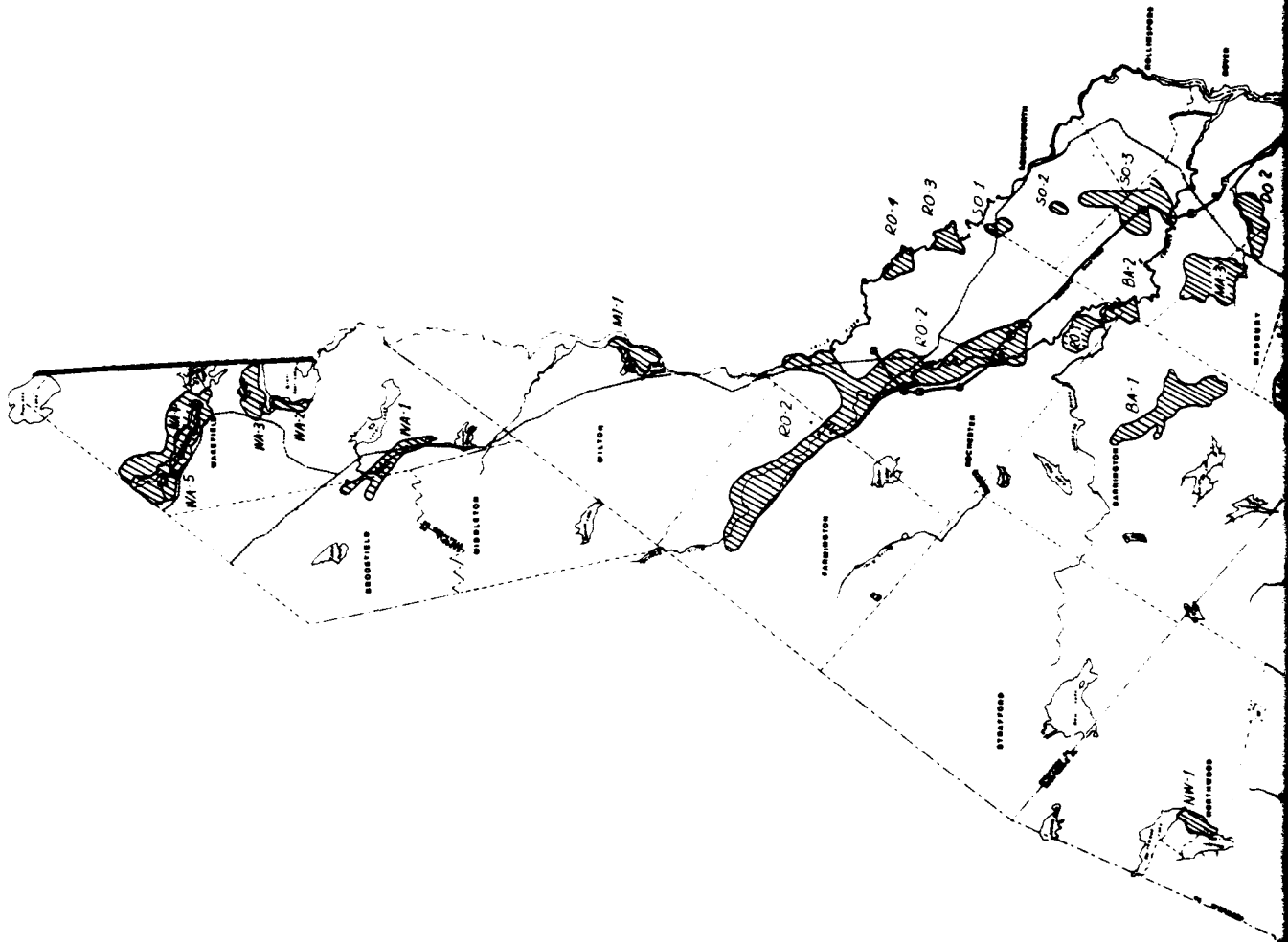
D. STUDY AREA

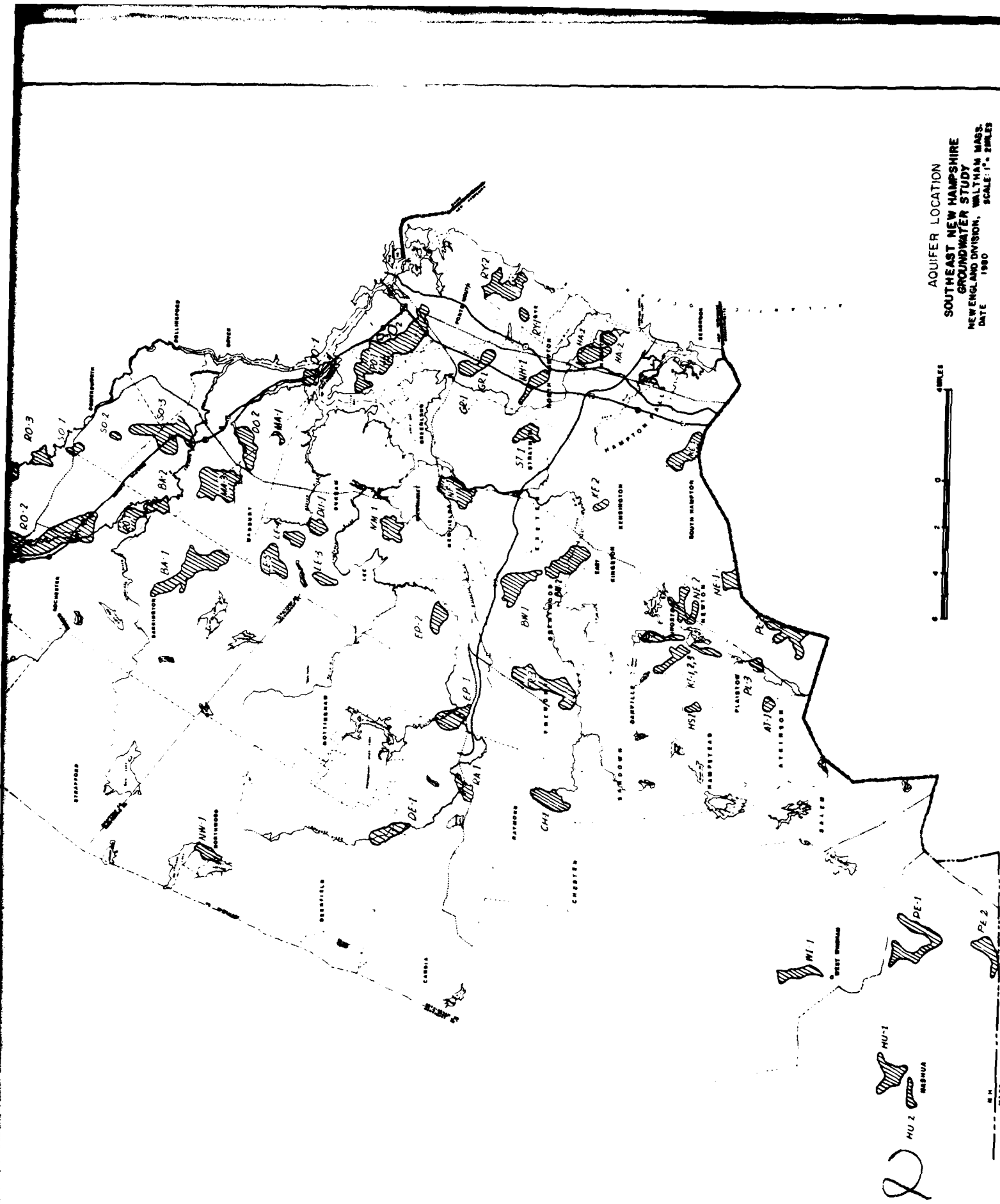
The study area encompasses approximately 1000 square miles and includes 50 communities of which approximately 50% are served by a public water supply system. The study area and the aquifers are shown on Figure 1. Of the communities investigated, 41 lie within the Piscataqua River Basin or the Coastal New Hampshire Basin while 9 communities - Atkinson, Hampstead, Hudson, Newton, Northwood, Pelham, Plaistow, Salem and Windham are in the Merrimack River Basin.

Physical Setting of the Basins

The study area lies within the Seaboard Lowland section of the New England Province, one of the subdivisions of the Appalachian Highlands (Fenneman, 1938). Further division of the area by D. Chapman (1976) divides the Seaboard Lowland into two areas: the Coastal Lowlands and Eastern Uplands.

The Coastal Lowland area is a low, undulating surface that rises gently to the northwest. The Eastern Uplands is characterized by low rolling hills that rise 100' to 300' above the valleys. Although stream drainage is generally southeastward to the ocean, many larger streams and many tributaries trend northeasterly or southwesterly, producing a sub-rectangular drainage pattern. This stream pattern can be attributed to the underlying rock and rock structures. In the western portion of the study area, principal drainage is received by the Merrimack River and several coastal streams flowing southeastward.





AQUIFER LOCATION
 SOUTHEAST NEW HAMPSHIRE
 GROUNDWATER STUDY
 NEW ENGLAND DIVISION, WALTHAM, MASS.
 DATE 1980 SCALE: 1" = 2MILES

FIGURE 1

Geologic Setting

The geologic framework may be divided into two general types of geologic units for simplicity of discussion: (1) the bedrock or consolidated rocks; and (2) the unconsolidated deposits, which overlie the bedrock.

Bedrock - Metamorphic rocks underlie most of southeastern New Hampshire and consist primarily of schist, gneiss, and quartzite (Novotny, 1969). In general, bedrock in the study area yield small but reliable supplies of groundwater from wells (Stewart, 1964). It is possible that as new techniques are applied to the evaluation of groundwater in bedrock through the utilization of specialized remote sensing techniques, zones of concentrations of potential water bearing fractures in the bedrock may be located. Yield data on wells located by fracture trace techniques are limited in New England area. However bedrock aquifers located by this technique could become a major public water supply source. However the scope of this report is to assess the groundwater potential in unconsolidated deposits.

Unconsolidated Deposits

Within the last million years, the Seacoast Area was invaded by continental ice sheets that spread southward from Canada. This period in geologic history is called the Pleistocene epoch having its most recent advance as the Wisconsin stage ending approximately 13,000 years ago (Golthwait, 1951). As the ice sheet advanced across the area, it eroded away some of the bedrock and most of the pre-existing unconsolidated deposits. Much of this material was incorporated in the ice and then subsequently spread over the bedrock surface as a veneer of unconsolidated rock material

which is known as glacial drift. The unconsolidated deposits in southeastern New Hampshire consist of sand, gravel, clay and silt. The glacial drift is further subdivided into stratified drift and till.

TILL - Till is an unconsolidated, non-stratified heterogeneous sediment deposited directly by glacial ice. This material is composed of rock particles of all sizes from clay to boulders. Till commonly known as "hardpan" is generally very compact and poorly sorted and is generally less than 15 feet in thickness in the study area (Bradley, 1964).

Till was a major source of water for private, domestic and farm use, however, due to its physical characteristics the hydraulic conductivity of till is low, and the saturated thickness is generally thin and variable and their dependable yield is quite low. Therefore, public water supplies obtainable from till are not evaluated in this report.

Stratified Drift - Stratified drift is an unconsolidated sediment deposited from glacial meltwater and composed of interbedded layers of gravel, sand, silt and clay. Meltwaters flowing into the sea formed marine deposits and are chiefly composed of clays and silts.

As the glacial ice melted, large bodies of stratified, coarse grained material were deposited by meltwaters flowing on, within, beneath, and beyond the glacier. Those deposits formed adjacent to a stagnant ice sheet are known as ice contact deposits. They

consist of kames, eskers, crevasse fillings, and kame terraces. Glacial meltwaters extending beyond an ice front left land forms known as valley trains, outwash fans, deltas and outwash plains (Embleton and King, 1975). Where depressions in the land surface existed or drainage was blocked by melting ice, shallow lakes were formed and silt and clay were deposited and are called glacio-lacustrine deposits.

When the ice sheet retreated from the seacoast region, the land remained depressed below sea level. As the ice melted the sea elevation rose to about what is now the 200 foot contour line and about 20 miles inland and marine sediments were deposited. Gradually differential uplift of the region led to the emergence of the coastal zone. Marine deposits do not yield significant amounts of water to wells and are principally a barrier to ground water movement.

E. WATER IN AQUIFERS

Hydrologic Cycle - The major source of recharge to the aquifers in the seacoast area is through precipitation directly on the stratified drift aquifer. As precipitation falls on the area, some of it flows over the land surface, some is evaporated or transpired back to the atmosphere, and some infiltrates into the ground (Figure 2). The overland flow reaches streams and is discharged from the area. Of the water that infiltrates into the ground, some is retained in the soils of unsaturated material, or the "zone of aeration"; and some percolates downward to the

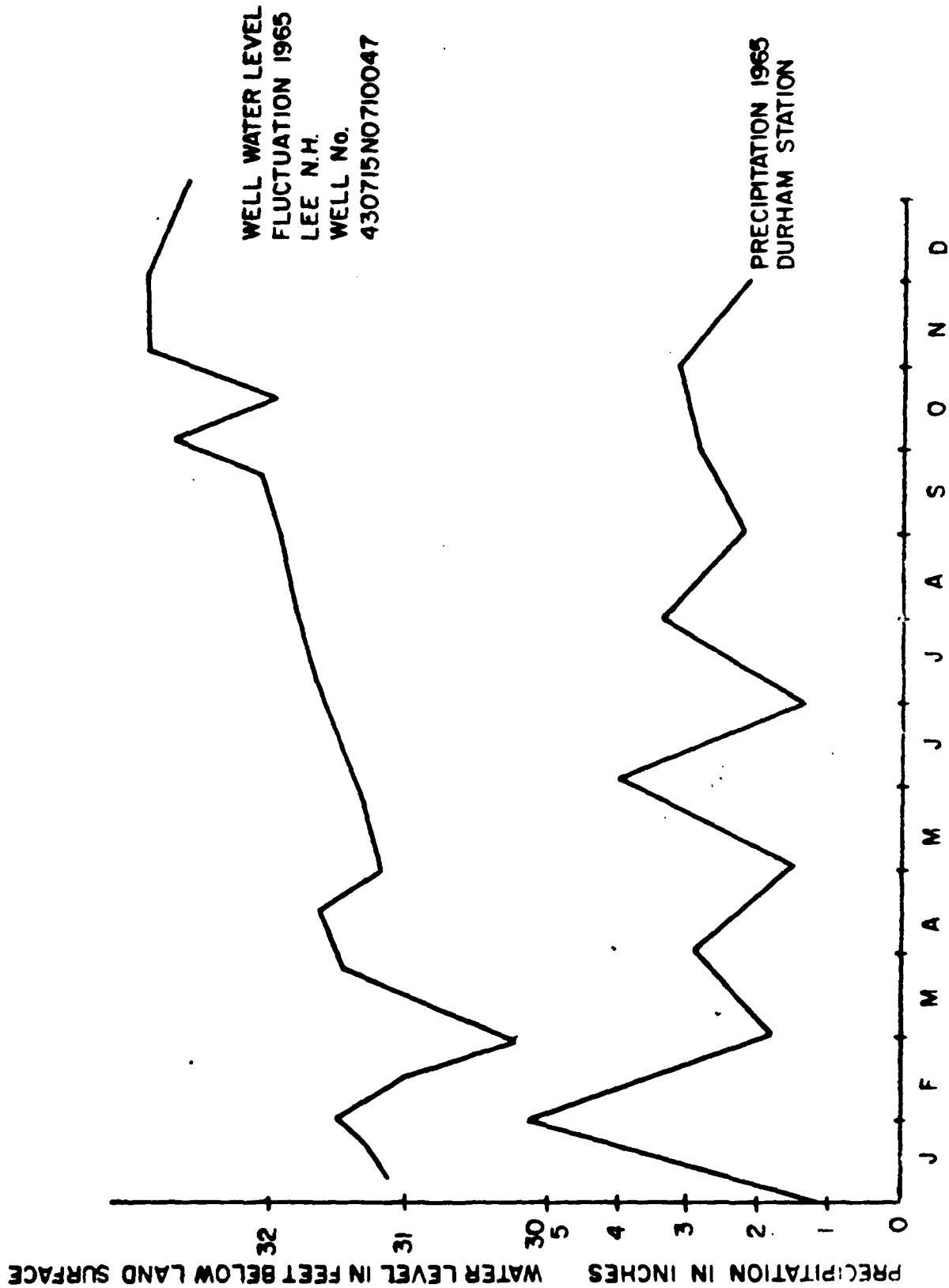


Figure 2. Fluctuations of water level in well No 430715NO710047 at Lee, N.H. and variation of precipitation at Durham, N.H. from January 1965 to December 1965.

"zone of saturation", in which all the pores are filled with water. The top surface of the zone of saturation is the water table, except where the zone is overlain by impermeable material and the ground water is confined. The water in the zone of saturation moves under the influence of gravity to points of discharge such as streams, lakes, or swamps.

Stream discharge from the basin represents water not returned to the atmosphere by evaporation and plant transpiration, which are collectively termed "evapotranspiration". In the seacoast area, approximately one-half of the average annual precipitation is returned to the atmosphere as evapotranspiration. The rate of evapotranspiration is variable during the year and from year to year and is directly related to factors such as precipitation, temperature, sunlight, amount of wind, and plant growth. During the winter months, little precipitation is lost through evaporation; and virtually none by transpiration. During the spring, evapotranspiration increases; but a sizable water surplus exists because snowmelt and precipitation more than balance the water loss. During the summer, evapotranspiration is at its peak and usually exceeds the precipitation rate. At this time plants withdraw water that has accumulated in the soil zone as a result of the water surplus of the previous spring. With a return to low temperatures and a decline in plant growth in the fall, the evapotranspiration rate falls below the precipitation rate and the soil water is replenished.

An accounting of the amount of water that enters the basin as precipitation, the amount that leaves the basin as evapotranspiration or stream discharges, and changes in the amount stored within the basin, either as surface or ground water, is called the "water budget".

Hydraulic Characteristics

The properties of stratified drift that control their ability to yield water are the storage coefficient, saturated thickness, hydraulic conductivity, and transmissivity. These terms are defined in the glossary Appendix (I).

Aquifer Storage

Aquifer storage occurs in unconsolidated materials containing void spaces between individual soil material. Below the water table the pores are filled with water. The water that is yielded from water bearing material by gravity drainage, as occurs when the water table declines, is termed specific yield. Since the majority of the aquifers in the study are unconfined the specific yield is virtually equal to the storage coefficient and is a dimensionless ratio expressed as a decimal fraction (Lohman, 1972).

The well sorted nature of sand and gravel aquifers is due to the smaller particles, silts and clays being carried farther away by the glacial meltwaters, with the coarser sands and

gravels forming the aquifer. Therefore, the smaller the range in particle size in a stratified drift sand and gravel aquifer the higher the porosity. Small particles would occupy the voids between the larger ones and result in a low porosity. The storage coefficient of most unconfined aquifers ranges from about 0.1 to 0.3 and averages about 0.2. This value then is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head (Lohman, 1972). As a result, sand and gravel aquifers contain the largest stored volume of water per unit area than any other aquifer.

Saturated Thickness

The saturated thickness is equal to the difference in elevation between the static water table in the stratified drift and the elevation of the underlying low permeable till and/or bedrock surface. Saturated thickness is a measure of the drawdown or head available for pumping. Therefore, the greater the storage coefficient and saturated thickness, the larger the volumes of water available for pumpage.

Hydraulic Conductivity

The ability of a porous material to transmit water is known as its hydraulic conductivity (k') and is expressed in units of ft/day. The range of hydraulic conductivities for unconsolidated deposits is large, due to the physical differences among the various materials. Therefore, the hydraulic conductivity of clay may be as low as 0.00013 ft/day and as much as 1.34 ft/day (Crain, 1974).

The saturated thickness (b) of the aquifer times the hydraulic conductivity (k) is equal to the transmissivity (T) and is expressed in units of ft^2/day . A deposit of sand and gravel 20 feet thick, fully saturated with water, and having a hydraulic conductivity of 700 ft/day , would have a transmissivity (T of $14,000 \text{ ft}^2/\text{day}$). Randall (1977) and Hurr (1972) developed average values of k for different lithologic units. The following table was developed by Randall (1977). The hydraulic conductivity values were developed for glacial deposits in central New York State and may be generally applied to glaciated aquifer-materials in New Hampshire. The values of hydraulic conductivity can be assigned to each lithologic unit, for each drilling log accompanying the site reports. Due to the heterogeneous nature of glacial aquifers, adjustments may be required in the hydraulic conductivity values assigned in this table.

TABLE 1

Estimated hydraulic conductivities of aquifer materials (Randall, 1977).

MATERIAL	HYDRAULIC CONDUCTIVITY (ft/day)
Gravel, fine to coarse, little or no sand or silt	2,700
Gravel, some sand, trace silt	2,000
Gravel and sand, trace silt, loose	1,300
Sand, coarse to very coarse, pebbly, clean, water-yielding	1,300
Sand, medium to very coarse, and gravel, clean, water-yielding	1,300

TABLE 1 (continued)

Sand, medium to very coarse, and gravel, slightly silty, water-yielding	1,000
Sand, medium to very coarse, clean, water-yielding (no gravel)	1,000
Sand, medium to very coarse, slightly silty	700
Sand, fine to coarse, pebbly, clean	700
Sand, some gravel	700
Sand, fine to coarse, pebbly, slightly silty	500
Sand, fine, some gravel	270
Sand and gravel, moderately silty	130
Silty sand and gravel	50
<u>Driller's log or equivalent</u>	
Gravel, coarse, water-yielding or screened	1,300
Gravel, coarse, not screened or described as water-yielding	1,000
Coarse sand and gravel, water-yielding or screened	1,000
Gravel, medium, not screened or described as water-yielding	800
Sand and gravel, or gravel, water-yielding or screened (no size modifiers, presumed to be fine-to-coarse sand)	700
Sand and gravel, or gravel, not screened or described as water-yielding	500
Fine sand and gravel, sand and gravel with some fine sand; not screened	270
Sand and gravel, some silt or clay	130
Gravel and silt	25
Gravel and clay	15
Silt, clay, hardpan	0.001 to 0.1

In glaciated aquifers and particularly the seacoast area the hydraulic conductivity can change rapidly within a very short distance. Therefore, caution must be exercised when applying hydraulic values to those areas of an aquifer where little or no data exists.

F. METHODOLOGY

The yield of an aquifer as a whole depends not only on what volume of water it can transmit to an individual well, but also on how much water is stored within and how much enters the aquifer naturally and by artificial means.

The factors affecting the availability of groundwater are:

1) recharge from precipitation, 2) lateral groundwater inflow, 3) recharge from adjacent till - bedrock uplands, 4) storage within the aquifer and 5) induced streambed infiltration. Components 1, 2, 3 and 5 can be summed as groundwater recharge. All of the parameters 1-5 comprise what is called the safe sustained yield of an individual aquifer.

Aquifer Delineation

In this report 56 aquifers which were previously delineated in the Phase I study, were evaluated to verify their size, location and lithologic composition. This work involved field inspection, geologic literature review, analysis of well drilling data, seismic and topographic mapping, and review of engineering reports, within the specified 56 Phase I aquifers. After the final delineation, the number of aquifers evaluated has increased from 56 to 61.

This report treats an aquifer as an unconsolidated geologic formation containing a minimum of 20 feet of saturated permeable material, which will yield significant quantities of water to wells for public usage. Generally, this range is in the order of 150 gpm per well.

In general, those aquifers that were eliminated were based on insufficient saturated thickness - 20 feet or less and/or low hydraulic conductivity values of 30 ft/day or less. The inclusion of new aquifers were based on values greater than those specified allowing some of the existing aquifers to be further subdivided.

Those aquifers in which no existing data were readily available remain unchanged from the Phase I delineation.

Recharge

The amount of groundwater recharge at any locality is dependent on two factors: (1) rate of infiltration through surficial deposits and (2) the amount and distribution of water available.

The movement of water into and out of the groundwater reservoir, as part of the hydrologic cycle, causes changes in the amount of water held in storage. Just as in any other container, whenever water is added or removed, water levels fluctuate, and we say that the water table is rising or is falling as the case may be. The addition of water to the groundwater reservoir is called recharge; the removal of water is called discharge. Figure 3 shows water-level fluctuations in the United States Geological Survey monitoring well in Lee, N.H. during the 1965 water year.

The overall pattern of water-level fluctuation in the hydrograph and the water levels are highest during the period January through April, gradually decline through the summer and early fall, and usually begin to rise during November.

Precipitation

Precipitation is the source of all recharge. For this reason the trend of precipitation would be expected to be similar to that of the water levels; that is, water levels should be highest when precipitation is heaviest. The records of all the weather stations in the basin, however, show that precipitation is nearly

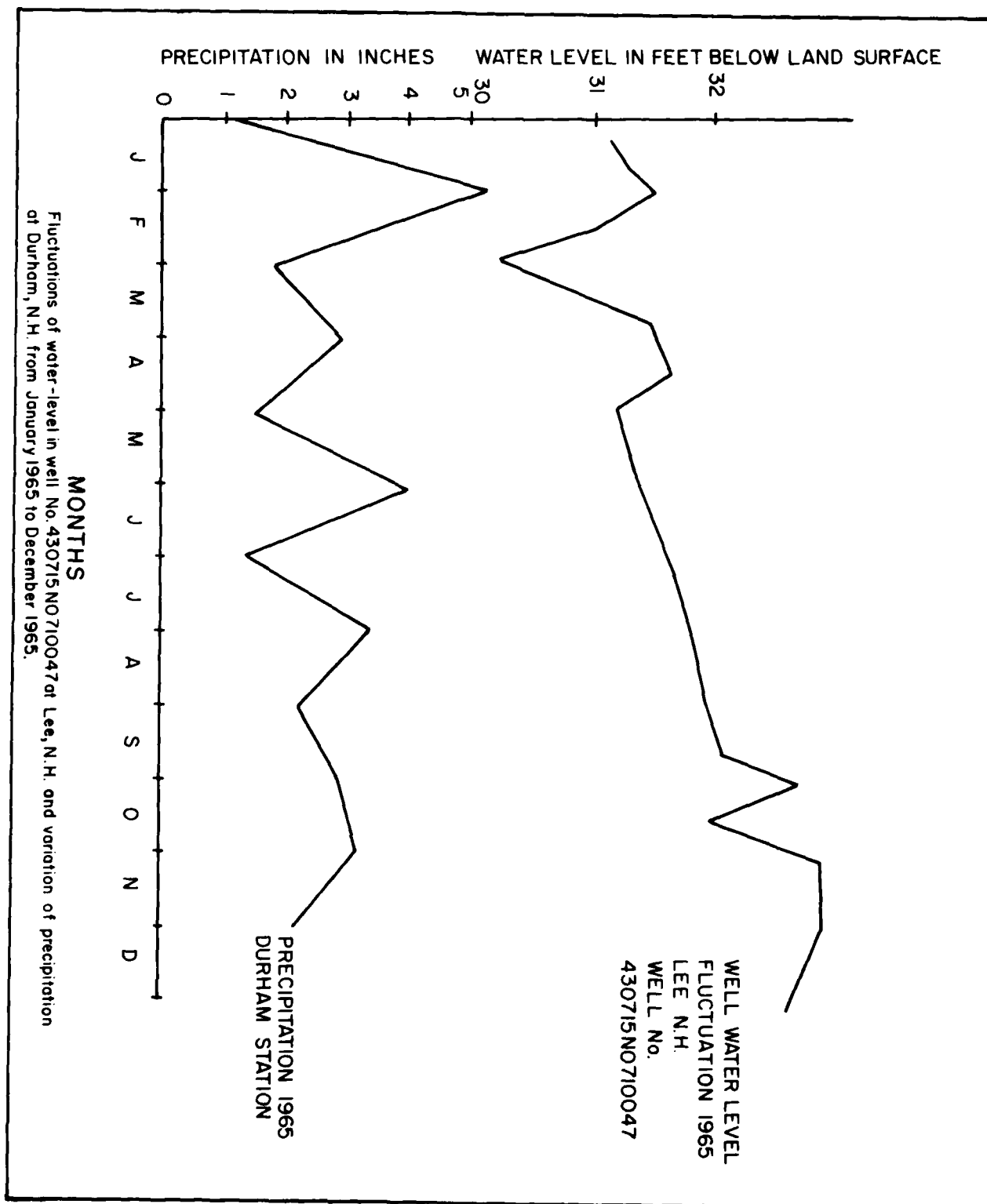


FIGURE 3

uniform throughout the year; in other words, there are no "wet" or "dry" periods.

There are large variations annually in the amounts of precipitation and evapotranspiration in the seacoast area. Records of precipitation at the National Weather Service climatological station in Durham, N.H. (see Figure 1 for town location) were analyzed for drought and average precipitation periods. The annual mean, monthly precipitation and departure from normal for 1965 and 1966 are shown in Table 2.

TABLE 2

Monthly Precipitation and Departure from Normals for the
Durham Station 1965 and 1966

1965

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
p	1.15	5.1	1.38	2.85	1.49	3.97	1.37	3.33	2.09	2.78	2.98	1.89	30.38
dp	2.58	2.17	-2.58	-.95	-1.83	.75	-2.13	.11	-1.48	-.39	-1.19	-1.70	-11.80

1966

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
p	7.1	2.88	2.80	1.09	3.37	3.65	3.19	2.75	5.65	3.73	4.74	3.13	44.1
dp	3.37	-0.05	-1.16	-2.71	0.05	0.43	-0.31	-0.47	2.08	0.56	0.57	-0.46	1.90

p = mean precipitation in inches

dp = departure from normal monthly precipitation

The mean annual precipitation for the Durham station during the 1965-1966 period was 42.18 inches. However, during 1965 only 30.38 inches of precipitation occurred with a departure from normal of 11.80 inches. During 1964, only 34.62 inches of precipitation occurred which in effect led to the "great drought of the 1960's",

that affected northeastern United States (Barksdale and others, 1960). In this report, hydrologic data for 1965 was used as the design year, for estimating the safe sustained yield.

Evapotranspiration

The amount of evapotranspiration in the Seacoast Study Area was estimated from the hydrologic simulation model called "Brook" at the Durham Station. The model was developed by C.A. Federer and D. Lash (1978) for the United States Department of Agriculture, Forest Service. The Brook model was validated for the Hubbard Brook Experimental Forest Station watershed in central New Hampshire and the Pemigewasset River at Plymouth, New Hampshire. The model is generally applicable for small, forested watersheds of 1 square mile, but the hydrologic principles also apply to a large watershed.

"Brook" in general, is a water-yield model for small areas primarily to study changes in stream flow and secondarily for drought simulation. It operates with a daily time interval, and requires daily precipitation and daily mean temperature as input variables. "Brook" simulates hardwood, conifer, mixed, cleared and regrowing vegetation types. It has been developed to examine stream flow response to different hardwood transpiration characteristics and to estimate soil - watered deficits.

Limitation of the Model

The Durham Station simulates a hardwood forest with till covered bedrock, where the aquifers we are evaluating are generally

forested, but are comprised of more permeable sands and gravels. Therefore, the calculated water surplus over a sand and gravel aquifer may be considered conservatively low in this report. Brook is far from a perfect model, it has a number of problems dealing with leaf evaporation, water movement in the root zone, slope and the determination of whether precipitation is rain or snow. However, in general, all hydrologic simulation models have limitations that restrict their use.

Water Surplus

The amount of water surplus (WS) that becomes available for recharge on sand and gravel aquifers was estimated from the Brook Model at the Durham Station. This method allows for the determination of potential evapotranspiration (PE), actual evapotranspiration (AE), surface runoff (SF), snowmelt runoff (SNF) and groundwater evaporation (GWE). The following is the water budget equation:

$$WS = P - AE - (SNF + SF + GWE)$$

where: P = precipitation in inches

AE = actual evapotranspiration

SNF = snowmelt runoff

SF = surface runoff

GWE = groundwater evaporation

Definitions of the previous terms can be found in the attached glossary Appendix (I). The values used in calculating the water surplus available for groundwater recharge are shown in Table 3. Groundwater evaporation is generally assumed to be 5% over the region,

TABLE 3

Precipitation, Evapotranspiration, and Water Surplus at the
Durham Station in the Seacoast Study Area during 1965 and 1966.

1965 DROUGHT YEAR

	P	AE	Runoff	GWE	WS
Jan.	1.15	0.25	0.08	0.0575	0.76
Feb.	5.1	0.20	1.9	0.255	2.74
Mar.	1.38	0.45	0.42	0.069	0.44
Apr.	2.85	0.69	0.62	0.142	1.4
May	1.49	1.8	0.008	0.0745	-0.39
June	3.97	3.9	0.29	0.198	-0.42
July	1.37	2.8	0.009	0.0685	-1.51
Aug.	3.33	2.7	0.027	0.1665	0.44
Sept.	2.09	2.5	0.019	0.1045	-0.53
Oct.	2.78	1.2	0.042	0.139	1.4
Nov.	2.98	0.44	0.3	0.149	2.1
Dec.	1.89	0.29	0.28	0.0945	1.2
TOTAL (inches)	30.4	17.25	4.1	1.5	7.55
Percent %P		56.5%	13.5%	5%	25%

(numbers shown are in inches)

TABLE 3 continued

1966 NORMAL YEAR

	P	AE	Runoff	GWE	WS
Jan.	7.1	0.26	1.88	0.355	4.61
Feb.	2.88	0.20	1.52	0.144	1.02
Mar.	2.80	0.49	1.74	0.14	0.43
Apr.	1.09	0.69	0.09	0.05	0.26
May	3.37	2.04	0.46	0.17	0.7
June	3.65	4.27	0.21	0.18	-1.01
July	3.19	2.80	0.04	0.16	0.19
Aug.	2.75	3.90	0.03	0.14	-1.32
Sept.	5.65	2.49	0.34	0.28	2.54
Oct.	3.73	1.15	0.88	0.19	1.51
Nov.	4.74	0.58	1.63	0.24	2.29
Dec.	3.13	0.33	0.20	0.16	2.44
TOTAL (inches)	44.1	19.20	9.04	2.2	13.65
Percent %P		43.5%	20.5%	5%	31%

(numbers shown are in inches)

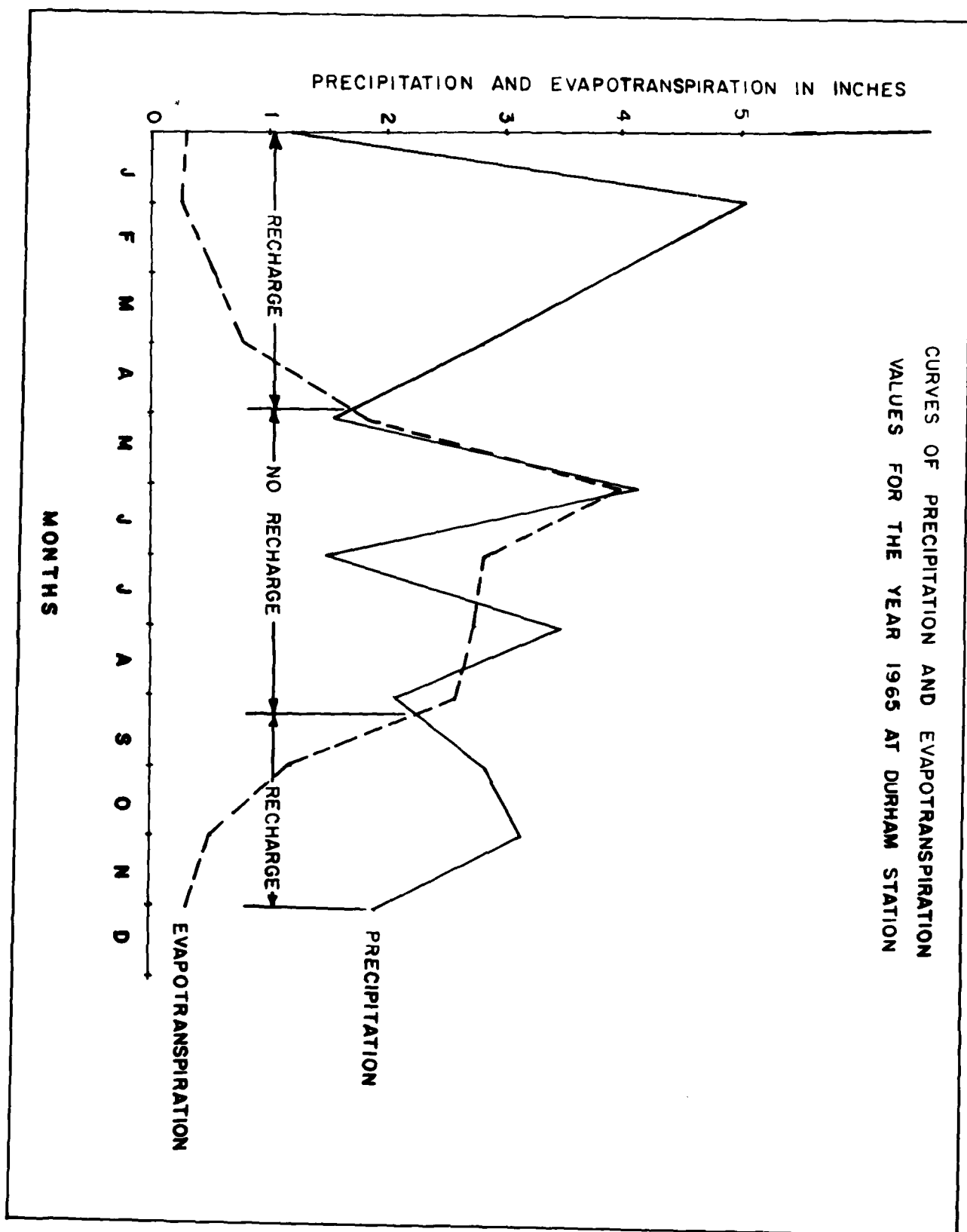
however, variations could be expected at each aquifer depending on plant and soil physical characteristics.

In Figure 4, the diagram indicates that recharge occurred approximately 7 months out of 12 during 1965. During August some recharge did occur, however this is unusual.

Recharge to Aquifer

The water surplus is the water available for groundwater recharge. The percentage of 1965 annual precipitation surplus by month is shown in Figure 5, which is based on the data in Table 3. The computed water surplus for the design year (1965) is 7.55 inches. It is assumed that all of this water surplus becomes groundwater recharge. The percentage of groundwater recharge (25%) correlates well with other studies (Crain, 1974), Kantrowitz (1970) and Cervion and others (1972). If the 7.55 inches is applied to a one square mile aquifer, approximately 132 million gallons annually recharges the groundwater during 1965 drought conditions, or 0.36 mgd. During a normal precipitation year, such as 1966 (Table 3), approximately 13.7 inches of precipitation directly recharges the aquifer or 238 million gallons annually and 0.65 mgd.

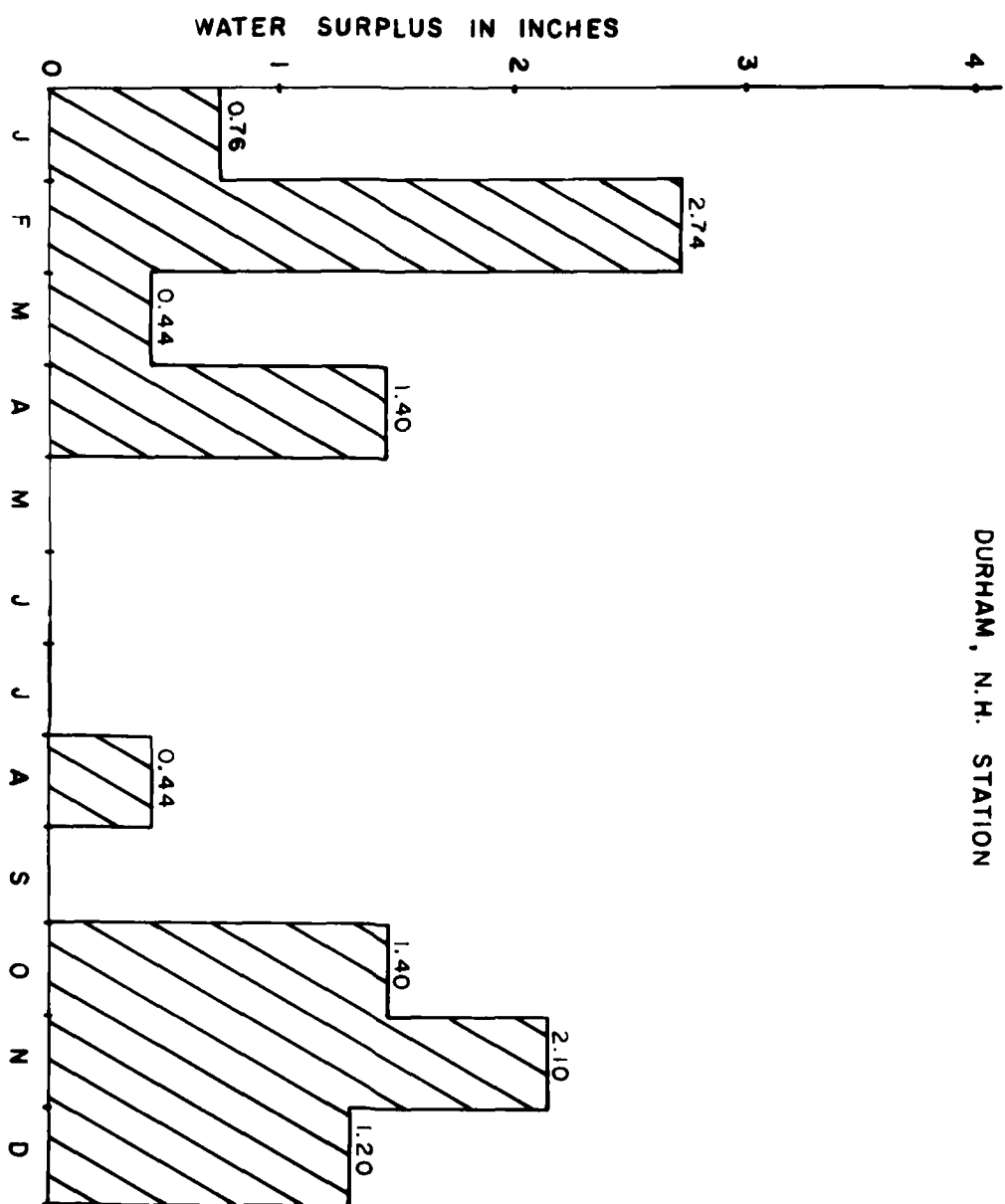
These values of 0.36 mgd and 0.65 mgd are considered conservatively low as explained previously. Individual simulation models designed for each site would give a more appropriate recharge value. However due to the paucity of aquifer data and budget restrictions, individual site modeling could not be performed as part of this study.



CURVES OF PRECIPITATION AND EVAPOTRANSPIRATION
VALUES FOR THE YEAR 1965 AT DURHAM STATION

FIGURE 4

MONTHLY WATER SURPLUS VALUES
DURHAM, N.H. STATION



Water surplus by month, for the 1965 design year, in the Seacoast Study Area.

FIGURE 5

Effect of Urbanization

Some sites, such as Rochester RO-2, have substantial urban areas that may increase runoff and reduce the groundwater recharge (Seaburn, 1970). It is felt that the regional effect of urbanization on the redelineated aquifers in the study area is insignificant. Most of the precipitation infiltrates into the aquifers, or is discharged onto the land surface, from roof gutters or diverted to open-bottomed catchbasins. In a study by Randall (1977, approximately 20-30 percent of the land surface was impervious to rainfall and actually helped to reduce groundwater evaporation.

Lateral Groundwater Inflow and Recharge from Adjacent Till Bedrock Upland

In the Seacoast Study Area, all of the aquifers receive groundwater flows from the adjacent till - bedrock uplands or from rather impervious sediments surrounding the aquifers. In this study, ice contact deposits are commonly surrounded by marine sediments and fine silty sands (Bradley, 1964). Hydraulic conductivities in till average 0.001 ft/day (Winslow and others, 1965) and are considered a small contributor of groundwater recharge.

The quantity of lateral groundwater inflow can normally be calculated in well-defined valleys, by delineating areas of adjacent till-and-bedrock upland that are not drained by streams. On an annual basis (assuming storage changes are negligible) one can calculate the quantity of water from the land surface into till or silt or clay by applying Darcy's law $Q = PIA$ to where Q is the quantity of water discharged in feet per day. P is the hydraulic conductivity in gallons per day per square foot. I is the hydraulic gradient

feet per foot, and A is the cross sectional area of the saturated thickness.

However due to the glaciated topography and marine deposition, most of the areas adjacent to the aquifers are very poorly defined. Their drainages are generally deranged and topographical divides are sometimes impossible to define.

Randall (1978) found that small streams draining onto aquifers contribute substantial groundwater recharge when the water tables are below the streambed during average precipitation years. However, in the Sea Coast Study Area during the drought conditions, it is felt that the base flow of small streams is derived primarily from groundwater in till. Therefore, the contribution of small streams flowing into aquifers in the study area is probably not a significant contributor of groundwater recharge, during drought conditions.

In this report, lateral groundwater inflow and recharge from adjacent streams and till - bedrock uplands become an undetermined recharge value that serve as a surplus recharge buffer to the safe sustained yield estimates.

Aquifer Storage - As mentioned earlier, in this report, the storage coefficient is an important parameter that determines the capacity of an aquifer to store water. An aquifer can be treated as a reservoir, which although underground, is usable in much the same way as a surface reservoir or water storage tank. If production wells are placed in an efficient pumping arrangement, water can be pumped

from storage. For example, if a 1 square mile aquifer has an average storage coefficient of 0.2, and has an average saturated thickness of 40 feet, approximately 1.7 billion gallons of water is held in storage. While this volume of stored water is enormous, a careful balance of withdrawal, versus recharge must be maintained or groundwater mining may result in a steadily declining water table (Poland and Davis, 1969).

It is reasonable to assume that during a drought of a 1965-1966 sequence the withdrawal of groundwater can be sustained at a rate of 7.55 inches (from storage) of water per square mile of aquifer, or 0.35 mgd, plus 7.55 inches from precipitation (1965 design year). This results in an annual withdrawal rate of 15 inches of water per square mile of aquifer or 0.7 mgd/mi². As shown in Table 4, which follows, the net deficit of stored water in an aquifer, at the end of the 1965-1966 sequence, would total 8.95 inches or 3.72 feet of saturated aquifer thickness (using a 0.2 storage coefficient).

Table 4 - Water Surplus - Storage Budgets for a 1 mi² Aquifer during a 1965-1966 Precipitation Sequence (in inches)

<u>Year</u>	<u>Available Recharge</u>	<u>Pumpage from Storage</u>	<u>Net Storage Deficit</u>
1965	7.55	15.10	7.55
1966	13.70	15.10	1.40
TOTAL	21.25	30.20	8.95

While the annual withdrawal rate will result in a net deficit of 8.95 inches, an undetermined buffer surplus from lateral groundwater inflow, runoff from bedrock-till uplands and small streams crossing the aquifer is generally available and should adequately replenish any

loss of storage. However, in those aquifers not having supplemental recharge other than storage, their water deficit will be replenished, only during above normal precipitation periods. In those aquifers having supplemental recharge, proper management techniques, such as decreased pumpage rates or a seasonal pumping schedule could allow aquifers like DO-1 in Dover (saltwater surrounds the aquifer) to be continuous productive water supply sources.

Induced Streambed Infiltration

While precipitation recharge, lateral groundwater inflow and storage provide direct recharge, sand and gravel aquifers hydraulically connected to large streams can receive additional recharge in the form of induced stream infiltration. In Figure 2, the groundwater flow regime shows the systems response due to well pumpage near a stream. The sustained pumping in a stratified aquifer creates a cone of depression that lowers the water table beneath adjacent streams, causing a reversal in the hydraulic gradient, inducing recharge from these surface water bodies toward the well. Walton (1963) and Weeks (1965) have found that the amount of water that can be obtained from stream infiltration is largely controlled by the hydraulic conductivity of the streambed material. Stream bottoms can be covered by a wide variety of materials ranging from silts and clays of low hydraulic conductivity, to finer medium sands of moderate hydraulic conductivity, to coarse clean sands and gravels of high hydraulic conductivity. Published field data on streambed hydraulic conductivities in New Hampshire are non-existent. Studies in Connecticut by Haeni (1978) and Rahn (1968), in New York by Randall (1977) and in Colorado (Moore and Jenkins, 1966) have found streambed

hydraulic conductivities ranging from 0.18 ft/day for fine silty sands to 5.68 ft/day in clean, coarse gravels. Several authors, Burkham (1970), Walton (1963) and Bouwer (1965), have found that the following factors affect the rate of streambed infiltration: vertical hydraulic conductivity, thickness of streambed materials, the effective area of streambed infiltration, the viscosity of the water, the average head difference between stream and aquifer and the quantity and velocity of water in the stream.

To include the parameters mentioned above, published field study values were evaluated from Rahn (1968), Randall (1977), (1978), Moore and Jenkins (1966), Walton (1966), Haeni (1978) and Cervione and others (1972), with hydraulic conductivity values being assigned to 4 types of streambed material found in the Seacoast area:

	<u>Material</u>	<u>Hydraulic Conductivity</u>
1	Sand and Gravel	1.36 ft/day
2	Silty Sand and Gravel	0.57 ft/day
3	Silty Fine to Medium Sand	0.18 ft/day
4	Clays	0 ft/day

The selected hydraulic conductivity value was then allocated to each stream traversing an aquifer. Head loss and thickness of the streambeds were not considered significant. The selected hydraulic conductivity value was then multiplied by the lowflow effective streambed area, (calculated in the field). Each assigned hydraulic conductivity and streambed area is included in the individual site report. The lowflow effective streambed area was considered the

wetted perimeter of the 90 percent duration of daily mean flow (the percentage of time a given flow is equalled or exceeded).

Stream Lowflows - The development of an aquifer recharge from induced stream infiltration can modify flow characteristics of a stream and at certain times such as a drought, or overpumping of an aquifer, dry up an adjacent stream. Therefore, lowflow analyses were used for streams in southeastern New Hampshire to determine the amount of water available in the streams for induced recharge to the aquifers.

The flow duration curve is a cumulative frequency curve that shows the percent of time during which specified discharges were equalled or exceeded. Therefore, it provides a convenient means for studying the flow characteristics of streams and for comparing one basin with another. The shape of a flow duration curve is of considerable significance. It reveals information about hydrologic and geologic characteristics of the drainage basin. A curve with a steep slope denotes a highly variable stream whose flow is largely from direct runoff, whereas a curve with a flat slope reveals the presence of surface or groundwater storage which tends to equalize the flow (Searcy, 1959) . The distribution of lowflows is controlled chiefly by the geology of the basin. Therefore, the lower end of the flow duration is a valuable means for studying the effect of geology on the groundwater runoff to the streams.

Calculation of Flow Duration - To develop a regional flow duration curve a distinction was made between regulated and unregulated streams. A "regulated stream" has been defined as a stream which is

influenced by any manmade structures and interferences that will have significant effect on the natural lowflow conditions of stream. The streams that may be hydraulically connected to the aquifers are shown in Table 7. All major streams except Salmon Falls River and Bellamy River were assumed to be unregulated. By analyzing the records of three unregulated gages in the region shown in Table 5, a regional flow duration curve (Figure 6) was developed for southeastern New Hampshire.

Table 5 : USGS Gages Utilized in the Preparation of the Flow Duration Curves

	<u>GAGE NO.</u>	<u>DRAINAGE AREA MI²</u>
Dudley Brook near Exeter (UR)	01073600	4.97
Mohawk Brook near Center Stratham (UR)	01072850	8.87
Oyster River near Durham (UR)	01073000	12.1
Salmon Falls River near Milton (R)	01072100	108.0

R: Regulated

UR: Unregulated

Figure 5 shows the regional flow duration curve which was obtained by averaging the coordinates of the flow duration curves of the three unregulated streams (Table 6):

Table 6 : Flow Duration Values Used in Regional Analysis

<u>percent of time flows are equalled or exceeded</u>	<u>Average Flows in CFS/MI²</u>			
	<u>Dudley Brook</u>	<u>Mohawk Brook</u>	<u>Oyster River</u>	<u>Regional Curve</u>
95	0.012	0.01	0.074	0.032
90	0.018	0.034	0.091	0.048
75	0.08	0.147	0.21	0.146
70	0.141	0.214	0.27	0.208
50	0.463	0.688	0.78	0.644
25	1.57	1.69	1.98	1.75
10	4.225	3.61	4.13	3.99

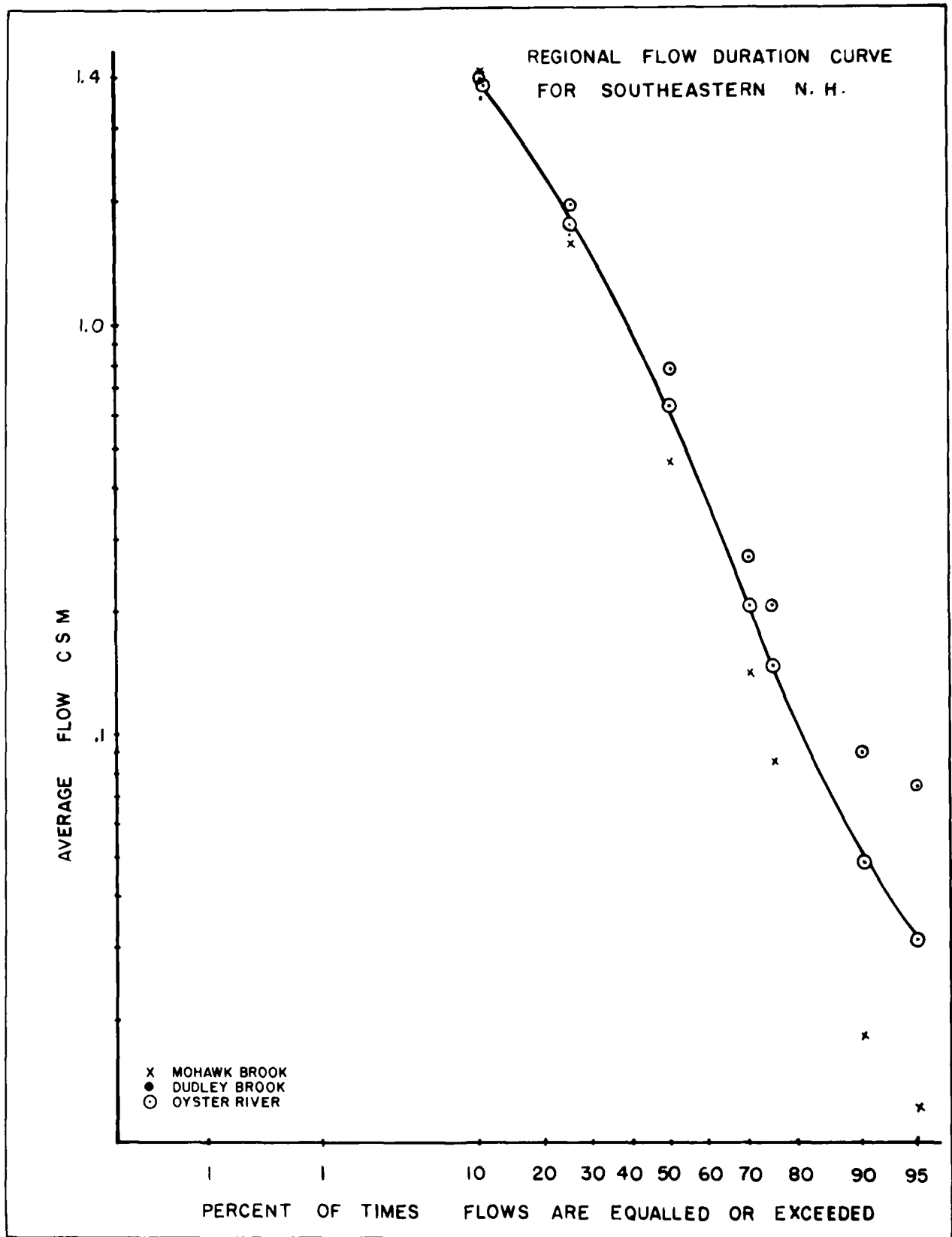


FIGURE 6

The flow duration curve (Figure 7) of Salmon Falls River was developed for those aquifers located within its drainage area.

The Bellamy Reservoir which is used for water supply for the Town of Portsmouth is located on the Bellamy River and controls stream-flow. It is possible that during a prolonged drought, no discharge would be allowed from the reservoir. This, plus the fact that there is no USGS gage on the Bellamy River prevents the means to quantify the amount of low flow available for induced recharge. Therefore, it was assumed that the Bellamy River low flows are not available for induced recharge to aquifers located within its drainage area.

Hydrologic analysis of gage records were performed by using the U.S. Geological survey computer model "WATSTOR", and the computer outputs that were used to develop the flow duration curves were obtained from the USGS office in Concord, New Hampshire for this study. The flows equalled or exceeded 90 percent of the time have been considered as indices of the streamflow available for induced recharge to the aquifers. Taken from the regional curve, this value is 0.049 CFS/MI^2 . The flow available 90 percent of the time for each aquifer in CFS is obtained by multiplying 0.049 CFS/MI^2 by the drainage area of the stream at the point where it enters the aquifer. The individual low flow values for each site are shown in Table 7.

Actual Available Induced Recharge - Where the calculated potential induced streambed infiltration value exceeds the 90% low flow duration for a stream, then the 90 percent flow duration will be used

TABLE - 7
Induced Stream Recharge to Aquifers in the Seacoast Study Area

Aquifer	Name of Stream or River	Stream Drainage Area (mi ²)	90% Streamflow Duration (CFS)	90% Streamflow Duration Available at Each Site (GPD) 1	Potential Induced Streambed Recharge (GPD)	Actual Induced Recharge (GPD)
BA-1	Mallego Brook	6.15	0.301	194,544	1,162,200	194,544
BA-2	Isinglass Cocheco	72.7 92.3	3.56 4.52	5,221,872	621,600	621,600
BA-1	Exeter	74.6	3.65	2,358,720	359,040	359,040
BA-2	Dudley Brook	6.7	0.33	213,270	56,246	56,246
CH-1	Exeter River Trib. Exeter	21.7 6.2	1.06 0.304	881,515	655,000	655,000
DE-1	Lamprey	31.3	1.53	988,848	168,180	168,180
EP-1	Lamprey	68.7	3.37	2,177,936	1,053,000	1,053,000
EP-2	Lamprey Trib. Lamprey	103. 0.63	5.05 0.031	3,283,200	261,754	261,750
FR-3	Exeter	50.3	2.46	1,589,760	625,000	625,000
HU-1	Glover Merrill	1.21 1.90	0.059 0.093	98,208	199,000	98,208
HU-2	First Merrimack	4.7 3092.0	0.23 663.6	429. x 10 ⁶	785,600	370,408 ²
LE-3	Little	18.54	0.91	587,520	275,400	275,400
LE-5	Oyster	5	0.245	158,400	72,800	72,800
MA-1	Johnson Creek	1.75	0.086	55,584	262,800	55,584
MA-3	Bellamy	-	-	0	0	0
NA-1	Winnicut	5.8	0.28	180,956	21,120	21,120
PE-1	Golden Brook	12.99	0.64	2,132,697	386,080	386,080

TABLE - 7 cont'd.
Induced Stream Recharge to Aquifers in the Seacoast Study Area

Aquifer	Name of Stream or River	Stream Drainage Area (mi ²)	90% Streamflow Duration (CFS)	90% Streamflow Duration Available at Each Site (GPD) ¹	Potential Induced Streambed Recharge (GPD)	Actual Induced Recharge (GPD)
PE-1 (cont'd)	Beaver Island Pond	51.51 2.87	2.52 0.14			
PE-2	Beaver	76.6	3.75	2,423,520	172,800	172,800
PL-3	Little	5.2	0.255	164,736	260,400	164,736
RO-1	Cocheco	92.3	4.52	2,921,184	19,040	19,040
RO-2	Mad Ela Cocheco Dams	10.34 10.52 15.33 5.6	2.05	1,305,469	6,489,600	1,305,469
RO-4	Salmon Falls	147	7.2	4,653,158	1,680,000	1,680,000
RA-1	Orway Lake Lamprey	9.4 51.9	0.46 2.54	1,938,816	1,008,000	1,008,000
SO-1	Salmon Falls	230	11.3	7,302,874	204,000	204,000
SO-2	Tates	2.14	0.105	67,824	4,000	4,000
WA-1	Lock Churchill	9.95 7.3	0.487 0.358	546,100	300,032	300,032
WT-1	Beaver	14.5	0.71	459,360	110,400	110,400
					Total =	10,111,029

¹ The values shown are the streamflow available at that individual site if developed separately. However, some streams have two or more aquifers that could induce streamflows, and accumulative total of the streamflow available at each site could exceed the 90% flow duration for that stream

² Value was determined by subtracting the Actual Induced Streambed Recharge used in HU-2 (98,208) from the First Brook Potential Induced Recharge (148,608 GPD) and adding the Potential Induced Streambed Recharge for the Merrinack River (320,000 GPD).

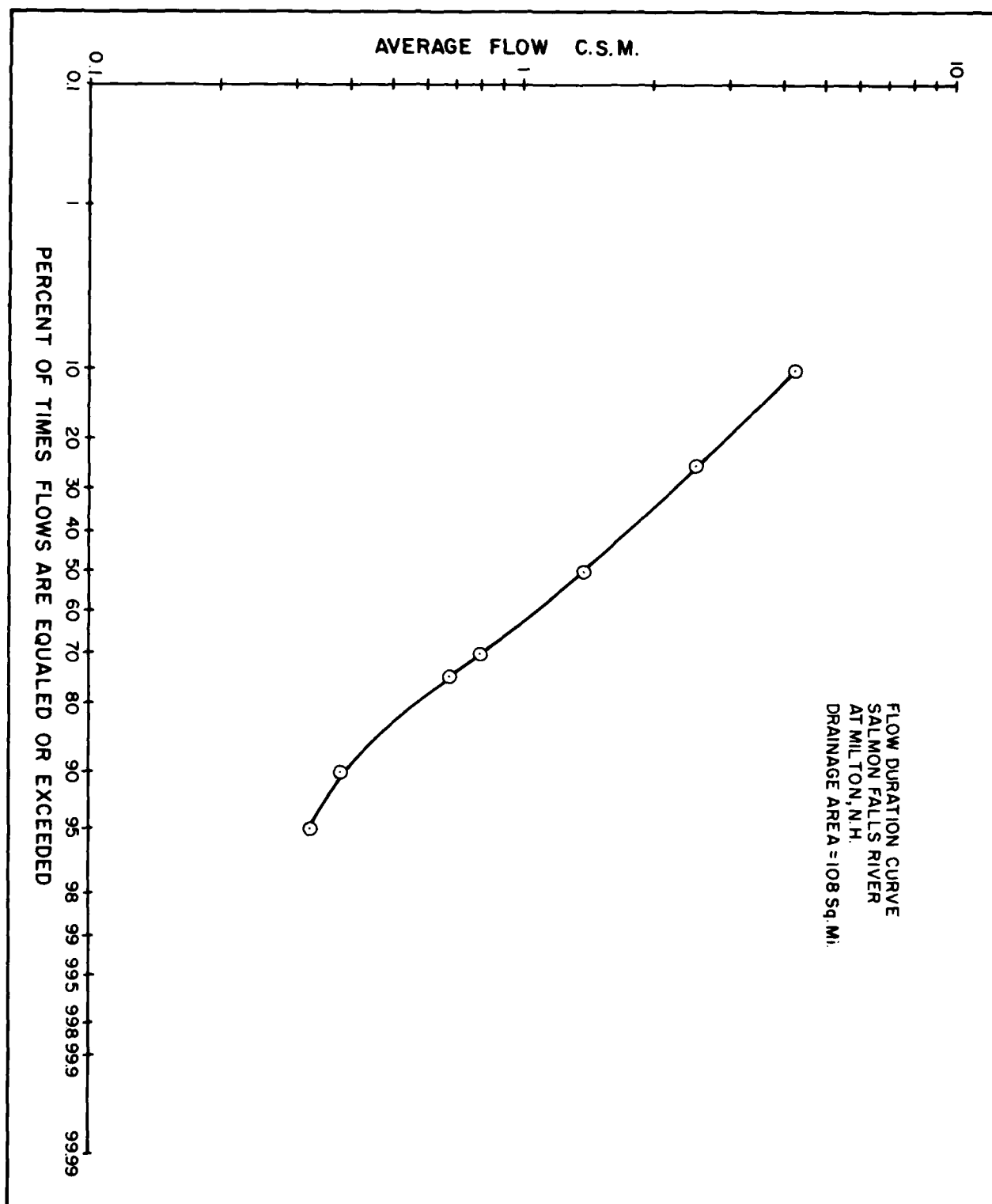


FIGURE 7

as the actual induced recharge. If the calculated potential induced streambed infiltration rate is less than the low flow value, then the potential streambed infiltration rate will be used.

If two or more aquifers are located on one stream, the upstream aquifer is assumed to have first use of the flow available 90 percent of the time. The actual induced recharge available to two or more aquifers on the same stream cannot exceed the streams total flow available 90 percent of the time. The actual induced recharge from streams for each individual aquifer is shown in Table 7.

Induced Infiltration from Surface Water Bodies - The study aquifers that are hydraulically connected to lakes or ponds may have the potential for additional recharge from induced infiltration. Lake and pond bottoms usually have very low hydraulic conductivities due to sedimentation and organic matter. McBridge and Pfannkuch (1975) found, on the basis of theoretical simulation, that for cases where the width of a lake is greater than the thickness of associated high-permeability surficial deposits, groundwater seepage into or out of a lake tends to be concentrated near the shore. Lee (1977) has documented this situation by a field study using seepage meters installed in a lake bottom.

Published data on hydraulic conductivities for lake bottoms in a glaciated terrain are scant. Also, an accurate determination of the effective lake bottom area that will contribute induced recharge to a hydraulically connected aquifer is difficult to determine.

Difficulty in estimating potential recharge from lakes in a northern climate is due to the lowering of lake levels in the fall to eliminate ice damage to docks and shorelines. As a result, those aquifers having the potential for induced recharge from surface water bodies are indicated in this study as requiring more detailed field investigation if further refinement in this area is desirable.

G. WATER QUALITY

The chemical quality of groundwater in the Seacoast Study Area is generally of high quality. Groundwater quality and its dissolved constituents, though generally low, vary greatly from place to place and reflect the solubility and chemical composition of the different rock types, with which the groundwater has been in contact. The groundwater quality changes are a response to changes in temperature, precipitation, vegetal decay, residence time, flow path and rates, and land use. These changes are especially prevalent in shallow stratified drift.

The most common constituents dissolved in groundwater in the Seacoast Area are iron, manganese, sodium, nitrates and chlorides with iron and manganese constituting the major groundwater quality problems in this area. The groundwater quality data available for each site can be found in Appendix C. The State of New Hampshire's 1978 Public Water Supply report is in Appendix D.

Iron and Manganese

Iron and Manganese are dissolved from rocks, primarily schists and

gneiss), and minerals, and from organic materials that accumulate in soils, marshes, bogs, and lakes. Their concentrations vary with time depending on changes in the acidity and dissolved oxygen content of the water. Iron and manganese are in solution in groundwater, with iron being in the form of the ferrous iron. Iron in the bedrock, sand and gravel is in the insoluble form of ferric iron.

When the dissolved manganese or ferrous iron enters different physical environments such as a well, water main or hot water heater tank, oxidation occurs to form hydroxides, which precipitate with a reddish brown and black color. On December 16, 1974, the Safe Drinking Water Act (SDWA) was signed into law. As directed by the Act, the Environmental Protection Agency (EPA) developed primary drinking water regulations designed to ensure safe drinking water for the public.

Iron and manganese which are commonly found in groundwaters are not health hazards. Water even with low concentrations of iron or manganese can stain fabrics, painted surfaces, porcelain fixtures and clog water mains. The SDWA recommends that the maximum concentrations in public water supplies for iron not exceed 0.3 milligrams per liter (mg/l) and manganese not to exceed 0.05 mg/l.

H. FIELD INVESTIGATIONS

(1) The field investigations for the Southeastern New Hampshire Groundwater Study, Phase II consisted of field reconnaissance by geotechnical personnel from the Army Corps of Engineers of 17 sites (32 aquifers) and 20 aquifers by geotechnical personnel from Anderson-Nichols & Co., Inc. Seismic refraction surveys were conducted at four sites (CH-1, FR-3, DE-I, RO-3,4) and one boring at Site RO-3.

(2) The field reconnaissances consisted of driving all accessible roads within and adjacent to the aquifers, discussions with local citizens and town officials, walking accessible areas, and recording the major geological and cultural elements within the aquifer site. Pertinent geological and cultural features observed in the course of the field reconnaissances were added to the appropriate site maps.

(3) Seismic refraction surveys were done on Sites CH-1, DE-I, and RO-3,4. The seismic lines were laid out by Corps of Engineers geotechnical personnel and the seismic surveys were run by a seismic contractor. The results of the seismic refraction surveys are found in Appendix F. The general locations of seismic lines for the appropriate sites are on the individual site maps located in the Aquifer Site Reports. For this study the seismic lines were used to locate the approximate groundwater surface, saturated thickness and to delineate the surficial area of the aquifers.

(4) One drive sample boring was completed at Site RO-3. The boring

log data may be found in Appendix G.

(5) Well logs, water quality and seismic data were collected from drilling contractors, engineering reports, Water Supply and Pollution Control, State of New Hampshire and from municipalities within the study area. The information was utilized to delineate the aquifer areas and to determine the safe sustained yields.

I. CONCLUSIONS

Results of the hydrogeologic analysis for 50 communities in the Southeastern New Hampshire Groundwater Study indicate that approximately 42.69 million gallons per day of water could be safely withdrawn from the 56 aquifers studied (Table 8). This rate should be able to be sustained during a 1965-1966 yearly precipitation sequence. If a series of 1965 precipitation years follow one another, pumpage at the safe sustained yield estimates may have to be reduced until normal precipitation resumes. The total amount of groundwater that can be withdrawn is limited by the hydrogeologic characteristics of the aquifer. As additional test boring, water quality, and geo-hydrologic data is gathered the aquifer delineations and safe sustained yield estimates will most likely change.

The quality of groundwater in the study area is good except with a few sites adversely affected by high concentration levels of iron and manganese. Several sanitary landfills are either located on or in close proximity to the aquifers. The landfills if hydraulically connected may pose a serious contamination threat to the future utilization of the aquifers as public water supply source.

TABLE 8

Summary of the Safe Sustained Yields for the 58 Aquifers.

TOWN	AQUIFER NUMBER	AQUIFER SURFICIAL AREA MI ²	GALLONS PER DAY gpd	STORAGE VOLUME gpd	INDUCED INFILT gpd	SUSTAINED YIELD mgd
Atkinson	AT-1	0.2	71,986	71,986		0.14
Barrington	BA-1	1.55	577,890	557,890	194,544	1.31
	BA-2	0.35	125,975	125,975	621,600	0.87
Brentwood	BW-1	1.24	446,312	446,312	359,040	1.25
	BW-2	1.0	359,929	359,929	56,246	0.78
Chester	CH-1	0.7	251,950	251,950	655,000	1.16
Deerfield	DE-1	0.88	316,738	316,738	168,180	0.80
Dover	DO-1	0.23	82,784	82,784		0.16
	DO-2	0.86	309,539	309,539		0.62
Durham	DU-1	0.14	50,390	50,390		0.10
Epping	EP-1	0.53	190,763	190,763	1,053,000	1.43
	EP-2	0.58	208,759	208,759	261,754	0.68
Fremont	FR-3	2.0	709,858	709,858	625,000	2.06
Greenland	GR-1	0.48	172,766	172,766		0.34
Hampton	HA-1	0.35	125,975	125,975		0.25
	HA-2	0.05	17,996	17,996		0.04
Hampstead	HS-1	0.19	68,387	68,387		0.14
Hudson	HU-1	0.52	166,060	166,060	98,208	0.43
	HU-2	0.10	35,993	35,993	370,408	0.44
Kensington	KE-1	0.66	237,553	237,553		0.47
	KE-2	E L I M I N A T E D				
Kingston	KE-3	0.45	161,968	161,968		0.32
	KI-1	0.234	88,183	88,183		0.18
	KI-2	0.157	56,508	56,508		0.11
	KI-3	0.26	93,582	93,582		0.19
Lee	LE-3	0.54	194,362	194,352	275,400	0.66
	LE-4	E L I M I N A T E D				
	LE-5	0.90	323,936	323,936	72,800	0.72
Madbury	MA-1	0.20	71,986	71,986	55,584	0.20
	MA-3	1.10	395,922	395,922		0.79
Milton	MI-1	0.43	154,770	154,770		0.31
Newfields	NF-1	E L I M I N A T E D				
Newton	NE-1	0.70	251,950	251,950		0.50
North Hampton	NE-2	0.70	251,950	251,950		0.50
	NH-1	0.62	223,156	223,156	21,120	0.47
Newmarket	NM-1	0.64	230,355	230,355		0.46
Northwood	NW-1	0.45	161,968	161,968		0.32

TABLE 8

Pelham	PE-1	1.90	683,866	683,866	386,080	1.75
	PE-2	0.45	161,968	161,968	172,800	0.50
Plaistow	PL-2	0.71	255,550	255,550	172,800	0.51
	PL-3	0.12	43,192	43,192	164,736	0.25
Portsmouth	PO-1	3.0	1,079,788	1,079,788		2.16
	PO-2	0.09	32,393	32,393		0.06
	PO-3	0.02	7,199	7,199		0.01
Raymond	RA-1	0.27	97,181	97,181	1,008,000	1.20
Rochester	RO-1	0.40	143,972	143,972	19,040	0.31
	RO-2	10.2	3,671,278	3,671,278	1,305,469	8.65
	RO-3	E L I M I N A T E D				
	RO-4	0.49	176,365	176,365	1,680,000	2.03
Rye	RY-1	0.08	28,794	28,794		0.06
	RY-2	E L I M I N A T E D				
Somersworth	SO-1	0.27	97,181	97,181	204,000	0.40
	SO-2	0.13	46,791	46,791	4,000	0.10
	SO-3	0.98	352,731	352,731		0.70
Stratham	ST-1	0.425	152,970	152,970		0.30
Wakefield	WA-1	1.11	399,521	399,521	300,032	1.10
	WA-2	0.42	151,170	151,170		0.30
	WA-3	0.97	349,131	349,131		0.70
	WA-4	0.97	349,131	349,131		0.70
	WA-5	1.53	550,692	550,692		1.10
Windham	WI-1	0.68	244,752	244,752	110,400	0.60
TOTAL						42.69

Although some of the aquifers studied have been extensively tested by borings and geophysical methods, the heterogeneous characteristics of the aquifers can not rule out the need for additional borings. In a glaciated aquifer, it is a common occurrence for the hydro-geologic characteristics to change rapidly within very short distances. However, the aquifers in this study that do not have readily obtainable test borings, water quality or geophysical data, should be investigated further. Also, some aquifers that require additional investigation are remotely located from urban population centers and the cost of making this water readily usable to the public may be prohibitively expensive.

AQUIFER SITE REPORTS

SITE AT-1, ATKINSON, NEW HAMPSHIRE

1. Introduction

Site AT-1 is located in the western part of Atkinson, N.H. The site evaluation consisted of a study of the U.S.G.S. topographic and geologic maps, the Phase I report and a site reconnaissance by Anderson-Nichols & Company, Inc.

2. Physical Characteristics

Aquifer Area - 0.2 mi ²	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results of Investigations

a. Surficial Conditions: The site is approximately 0.2 square miles in area. There are no major streams that can be considered a source of induced recharge to the aquifer. AT-1 is under heavy residential sub-division development pressure. Dug wells in the area are at about 15 feet and have frequently gone dry during periods of drought.

b. Subsurface Conditions: The aquifer at the Atkinson site is a small outwash fan built into an outwash plain. An ice contact deposit is found at the western end of the aquifer. There is no record of test borings being conducted in the area. As a result, the saturated thickness or lithology could not be estimated.

c. Yield Estimate: The only source of recharge to this site is precipitation. The safe sustained yield from this site is estimated to be 0.14 mgd. This small yield can be attributed to the small surficial area and the absence of stream recharge.

d. Water Quality: No groundwater quality data was readily obtainable for this site.

4. Conclusions and Recommendations

The small aquifer area limits its potential for groundwater recharge from precipitation and pumpage from storage. Site investigation should be conducted to determine the aquifers saturated thickness and to better define its aerial extent.

SITE BA-1, BARRINGTON, NEW HAMPSHIRE

1. Introduction

Site BA-1 is located in the eastern part of Barrington, N.H. The site evaluation consisted of a study of the U.S.G.S. topographic and geologic maps, the Phase 1 report, and a reconnaissance by geotechnical personnel from the Corps of Engineers in March 1979. Existing seismic and test well borings were also evaluated.

2. Physical Characteristics

Aquifer Area - 1.55	Stream Width - 6.5 feet
Recharge Streams - Mallego Brook	Streambed Area - 96,850 feet ²
Streambed Material - Sand and Gravel	
Stream Length - 14,900 feet	Streambed Infiltration Rate - 12gpd/ft ²

3. Results of Investigation

a. Surficial Conditions: The aquifer has no municipal wells and is presently occupied by small individual wells for residential and small business developments. The site is approximately 1.55 square miles in area. Two sand pits composed of fine, silty sands are located within the aquifer site. Mallego Brook is considered the only large stream capable of supplying significant induced recharge to the aquifer.

b. Subsurface Conditions: The aquifer is an outwash plain with ice contact deposits in the southeastern section. Winkley Pond is considered a kettle hole pond. The aquifer is bordered

on the east by marine deposits and till uplands on the west. A bedrock outcrop is located 600 feet south of Barrington Center. The location of test borings in the reports by Bradley (1962) and Whitman and Howard, Inc. (1977) and seismic data by Dean (1977) are shown on Plate 1. The data indicates the aquifer is comprised of medium to coarse sand to a depth of 42 feet in the northwest section and coarse sand and gravel to a depth 56 feet in a gravel pit to the southeast near Winkley Pond. The static water levels ranged from 15 feet at T.W. 26-77 to 3 feet at T.W. 27-77.

c. Yield Estimate: Based on the available induced recharge from Mallego Brook, storage and precipitation, the safe sustained yield for BA-1 is estimated to be 1.31 mgd.

d. Water Quality: Laboratory results for T.W. 26-77 indicates the listed contaminant levels are within the Safe Drinking Water Drinking Water Act limits of 1978. No water quality information was found for this reach of Mallego Brook which acts as a recharge stream for this aquifer.

4. Conclusions and Recommendations

It is recommended that additional test borings be completed that would permit further delineation of the surficial area, saturated thickness and lithology.

SITE BA-2, BARRINGTON, NEW HAMPSHIRE

1. Introduction

Site BA-2 is located in the northeast corner of Barrington, N.H. and extends into Rochester and Dover, N.H. This area is locally referred to as the "Hoppers". The site evaluation consisted of a study of the U.S.G.S. topographic and geologic maps, the Phase I report, and a reconnaissance by personnel from the Anderson-Nichols & Company, Inc. Existing test well borings were also evaluated.

2. Physical Characteristics

Aquifer Area - 0.35	Stream Width - 30ft/45ft
Recharge Streams - Isinglass, Cocheco	Streambed Area - 105,000ft ² 283,500ft ²
Streambed Material - Sand and silt	Streambed
Stream Length - 3500 ft, 6300 ft	Infiltration Rate -1.6gpd/ft ²

3. Results of Investigation

a. Surficial Conditions: The site has a surficial area of approximately 0.35 square miles. The area is undergoing intense subdivision development at this time. There is a junk yard on the southern edge of this area and a recently closed sanitary landfill about ½ mile south of this aquifer. There are active gravel pits in the area that have exposures of up to 100 feet of sand and gravel. The Isinglass and Cocheco Rivers are considered potential induced recharge sources to the aquifer. However, discontinuous marine deposits lying between the aquifer and the rivers probably limit recharge potential (Bradley, 1964).

b. Subsurface Conditions: The aquifer site is an ice contact feature that is comprised of several kettle holes. Physical inspection of the kettle holes found well rounded sands and gravels on the surface.

Test borings by Camp, Dresser & McKee (1971) are shown on Plate 1. The test borings indicate that medium sand and gravel extends to a maximum depth of 195 feet (T.W. 70-10). However, the lithology of the aquifer varies greatly throughout the aquifer where T.W. 70-17 indicates find sand, gravel and clay to a depth of 102 feet. The static water levels ranged from 9 feet at T.W. D-21 to 59 feet at T.W. 70-12.

c. Yield Estimate: Test pumping at this site by the Corps of Engineers in 1952 and 1953 indicated a yield of 2.5 mgd is possible. In a report by Camp, Dresser & McKee (1971) the estimated capacity of the aquifer was 3.5 mgd. Discussions with Mr. Leahy, Water Superintendent, City of Dover, New Hampshire, indicated that a 1,000 gpm pumping rate from the Caulderwood Well could not be continuously sustained 24 hours a day. Mr. Leahy felt the aquifer has limited recharge capabilities. Presently the well is being pumped at 500 gpm (0.72 gpm)

Based on streambed infiltration rate of 1.68 pd/ft^2 from the Isinglass and Cocheco Rivers, storage, and precipitation, approximately 0.87 mgd is estimated as the safe sustained yield. However

a higher safe sustained yield may be available if a more detailed field investigation indicates that streambed materials of higher conductivity exists in the Isinglass and Cocheco Rivers.

d. Water Quality: Laboratory results for T.W. 70-9 indicate that listed contaminant levels are within the Safe Drinking Water Act limits of 1978. The reaches of the Isinglass and Cocheco Rivers which act as recharge streams for this aquifer, are designated by the New Hampshire WSPCC as Class C streams. Class C streams are acceptable for recreational boating, fishing, and industrial water supply with or without treatment. No information could be found on iron or manganese concentrations or any other water quality parameters for these reaches of the Isinglass and Cocheco Rivers.

4. Conclusions and Recommendations:

Marine deposits probably reduce the potential for recharge from the Isinglass and Cocheco Rivers to the aquifer. Monitoring of the existing test wells and the installation of new wells is recommended to determine the hydraulic capabilities of the two rivers.

SITE BW-1, BRENTWOOD, NEW HAMPSHIRE

1. Introduction

Site BW-1 is located in the southeastern segment of Brentwood and the western portion of Exeter. Investigation consisted of a study of the U.S.G.S. topographic and geologic maps, and review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 1.24 mi ²	Streambed Width - 34 ft. Streambed Area - 224,400 ft ²
Recharge Streams - Exeter River	Streambed Infiltration Rate - 1.6 gpd/ft ²
Streambed Material - Standard Silt	
Stream Length - 6600 ft.	

3. Results of Investigation

- a. Surficial Conditions: The site has a surficial area of 1.24 square miles. No municipal wells are known to exist on this site. A sanitary landfill adjacent to the Exeter River and a dump in an abandoned gravel pit exist within the aquifer. Gravel pits were observed throughout the aquifer areas with 30-40 foot gravel faces above the existing land surface.
- b. Subsurface Conditions: The aquifer is a composite of ice contact deposits adjoining an outwash plain. Till borders the southern perimeter and marine deposits on the east and

west. Well stratified sediments were found in the sand and gravel pits within the site. The well logs, U.S.G.S. 11 and 10 by Bradley (1962) indicates a thickness of 90 and 66 feet respectively at those borings. No other well logs existed for this site.

c. Yield Estimate: Based on the available induced recharge from the Exeter River, storage and precipitation, the safe sustained yield is estimated to be 1.25 mgd.

d. Water Quality: Data on the quality of the groundwater was not readily obtained for this report. This reach of the Exeter River which acts as a recharge stream for the aquifer, is designated by the New Hampshire WSPCC as a Class B river. Class B rivers are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Exeter River.

4. Conclusions and Recommendations:

The landfills and dumps may restrict the water supply development of the aquifer. Test borings and sanitary analyses should be conducted to evaluate the lithology and levels of leachate contamination.

SITE BW-2, BRENTWOOD, NEW HAMPSHIRE

1. Introduction

Site BW-2 is located in the northeastern corner of Brentwood. Investigations consisted of a review of the U.S.G.S. topographic and geologic maps, and a review of the Phase I report. The reviews were followed by a reconnaissance of the site by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 1.0	Stream Width - 6 ft.
Recharge Streams - Dudley Brook	Streambed Area - 35,154 ft ²
Streambed Material - Sand and Silt	Streambed Infiltration
Stream Length - 5,859 ft.	Rate - 1.6 gpd/ft ²

3. Results of Investigation

a. Surficial Conditions: The site has a surficial area of 1.24 square miles. Site BW-2 has a public well of undetermined size and yield. Gravel pits were observed throughout the aquifer areas with 30-40 foot gravel exposures above the existing land surface. A sand and gravel mining operation is located along the entire extent of BW-2.

b. Subsurface Conditions: The aquifer appears to be ice contact deposits associated with a small outwash plain. Surrounding the site are marine deposits on the west and fine grained outwash deposits to the east and north. There is no record of

test borings in the area. As a result the saturated thickness or lithology could not be estimated.

c. Yield Estimate: Based on induced recharge from Dudley Brook, storage and precipitation, the safe sustained yield is estimated to be 0.78 mgd.

d. Water Quality: Data on groundwater quality was not readily obtainable for this site. This reach of Dudley Brook, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class B river. Class B rivers are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of Dudley Brook.

4. Conclusions and Recommendations:

While induced recharge from Dudley Brook is limited, the aquifer has a substantial surficial area for recharge from precipitation. Test borings are recommended to determine the aquifers geohydrologic properties.

SITE CH-1, CHESTER, NEW HAMPSHIRE

1. Introduction

Site CH-1 is located principally in the Town of Chester, N.H. with a small extension into the adjoining town of Raymond, N.H. Investigations consisted of review of USGS topographic and geologic maps and a review of a reconnaissance by others as summarized in the Phase I report. The reviews were followed up by a reconnaissance of the site by geotechnical personnel from the Corps of Engineers. A seismic refraction survey was completed at Site CH-1 for the Corps of Engineers (See Appendix F).

2. Physical Characteristics

Aquifer Area - 0.7

Streambed Area - 116,600 ft²
- 45,000 ft²

Recharge Streams - Exeter River/
Tributary to Exeter River

Streambed Infiltration

Streambed Material - Silt, Sand, Gravel/
Sand and Silt

Rate - 5gpdft²/1.6gpdft²

Stream Length - 5300ft/4500ft

Stream Width - 22 ft/10 ft

3. Results of Investigations

a. Surficial Conditions: Site CH-1 has no municipal wells at present. The site is lightly developed but there are plans for residential development. Route 102 bisects the site which is bordered on the east by the Exeter River. There is a sanitary landfill at the northern boundary of the site. There are two active gravel pits within the site. Total site area is approxi-

mately 0.7 square mile.

b. Subsurface Conditions: The aquifer is composed of ice contact features consisting of a kame terrace with kettle holes having steep ice contact slopes bordering the deposit. Examination of gravel pits near Route 102 show up to 20 feet of stratified sands and gravel exposed in the pit walls above the water table. The seismic refraction survey indicates that the maximum saturated thickness is in the order of 40 feet. The seismic refraction report is in Appendix F. In general, the bedrock surface slopes eastward and the thickness of the deposit increases in a southerly direction toward the Exeter River. The aquifer delineation was based on the seismic profiles.

c. Yield Estimate: The surficial area of the aquifer is 0.7 square miles. Wells in a deposit with a saturated thickness of 40 feet at this site are suitable for development of a municipal supply. The safe sustained yield is estimated to be 1.16 mgd at CH-1. The Exeter River and the tributary to the Exeter River are assumed to be hydraulically connected to the aquifer.

d. Water Quality: Data on groundwater quality was not readily obtainable for this site. This reach of the Exeter River and the Exeter River tributary, which act as recharge streams for this aquifer, are designated by the New Hampshire WSPCC as a Class B river. Class B rivers are acceptable for swimming and other recreation, fish habitat, and, after adequate

treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for these reaches of the Exeter River and the Exeter River tributary.

4. Conclusions and Recommendations

Test borings should be conducted in the eastern section of the aquifer to determine the geohydrologic properties. The sanitary landfill adjacent to the sites northern boundary should be evaluated for potential contamination of the aquifer.

SITE DE-1, DEERFIELD, NEW HAMPSHIRE

1. Introduction

Site DE-1 is located in the southeast corner of Deerfield, N.H. extending into Raymond and Candia, N.H. and is partially bisected by the Lamprey River. Investigations consisted of review of USGS topographic and geologic maps and a review of reconnaissance by others as summarized in the Phase I report. A reconnaissance was also made by geotechnical personnel of the Corps of Engineers. A seismic refraction survey was made at this site.

2. Physical Characteristics

Aquifer Area - 0.88 mi^2

Stream Width - 22 ft
Streambed Area - $13,348 \text{ ft}^2$

Recharge Streams - Lamprey

Streambed Infiltration

Streambed Material - Sand and Gravel

Rate - 12.6 gpd/ft^2

Stream Length - 607 ft

3. Results of Investigations

a. Surface Conditions: There are no municipal wells on this site. However, the Deerfield Fairground has several wells that have produced high yields for several days during fair operation. The site is approximately 0.88 square miles in area. Overall the site is sparsely developed with residential dwellings. The Deerfield Fairgrounds is located at the northern end of the aquifer. The principal restraints on groundwater development within DE-1 are the effects of the closed sanitary landfills within the Deerfield Fairgrounds. These landfills were utilized

by the town of Deerfield. The landfills are in gravel deposits adjacent to the Lamprey River.

Field investigations by John Cotton of the United States Geological Survey found four areas of bedrock outcrops near the delineated aquifer (see Plate 1 - DE-1).

b. Subsurface Conditions: The aquifer consists of ice contact and outwash features, including eskers, kames and valley train deposits in a narrow valley confined between till mantled rock controlled hills. The area consists of two ice contact deposits at different elevations. Those at the higher elevations have been extensively mined for sand and gravel. The seismic studies, Appendix F, were run at the lower elevations where the deposits extend below the water table. Saturated thicknesses of 15-50 feet were indicated by the seismic refraction survey. Approximately 30% of the Lamprey streambed length was eliminated as having a possible hydraulic connection to the aquifer. This was based on the assumption that the Lamprey River was flowing on bedrock.

c. Yield Estimate: This site is estimated to have a safe sustained yield of 0.8 mgd based on precipitation recharge, storage and potential induced infiltration from the Lamprey River.

d. Water Quality: Data on groundwater quality was not readily obtainable at this site. This reach of the Lamprey River, which

acts as a recharge stream for this aquifer, is designated by the Lamprey River, is designated by the New Hampshire WSPCC as a Class B river. Class B rivers are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Lamprey River.

4. Conclusions and Recommendations

Based on the favorable results of the seismic refraction survey indicating saturated zones of up to 50 feet in depth, along with the other favorable geologic conditions of Site DE-1, the site warrants further explorations. The sanitary landfills should be investigated for their impact on the groundwater quality of the aquifer. If test boring information indicates sufficient saturated thickness, lithology, and pump testing should be conducted to further define possible yield of site.

DO-1, DOVER, NEW HAMPSHIRE

1. Introduction

Site DO-1 is located at the south end of Dover Point, in Dover, N.H. The site investigations consisted of a review of U.S.G.S. topographic and geologic maps, Phase I report and a site reconnaissance by personnel of Anderson-Nichols & Company, Inc.

2. Physical Characteristics

Aquifer Area - 0.23 mi^2

Stream Width - None

Recharge Streams - None

Streambed Area - None

Streambed Material - None

Streambed Infiltration Rate - None

Stream Length - None

3. Results of Investigation

a. Surficial Conditions: The aquifer site is approximately 0.23 square miles in area. Tidal flats border the aquifer and are undergoing very heavy development at this time. Sewers are currently being installed although a large number of residences will remain on septic systems for the immediate future. The area is bisected by Route 16 and the Spaulding Turnpike with fill from the construction of the interchange covering a large portion of the aquifer.

b. Subsurface Conditions: The site is located at the sound end of an ice contact deposit which occupies a strip of land between the Piscataqua and Bellamy Rivers. This feature is

partially buried beneath marine deposits which border the east and west edges of the deposit.

Well logs by Bradley (1962) indicate sand and gravel deposits at a depth of 40-86 feet. The Cote Well (abandoned) used to serve as an emergency supply for the City of Dover.

c. Yield Estimate: The only source of yield from this site is through precipitation and storage. The safe sustained yield is estimated to be 0.16 mgd.

d. Water Quality: Data on the groundwater quality at this site was not readily obtainable.

4. Conclusions and Recommendations

Possible saltwater intrusion and the highway construction severely restrict DO-1 as a municipal water supply site. No further testing is recommended for this site.

DO-2, DOVER, NEW HAMPSHIRE

1. Introduction

Site DO-2 is located half in Dover and half in Madbury, N.H. The site investigations consisted of a review of U.S.G.S. topographic and geologic maps, Phase I report and a site reconnaissance by personnel of Anderson-Nichols & Company, Inc.

2. Physical Characteristics

Aquifer Area - 0.86 mi^2	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results of Investigation

a. Surficial Conditions: The site is approximately 0.86 square miles in area and is undergoing moderate residential development at this time. There is a large scrap metal shredding plant located in an old gravel pit, and a cement plant in the area. Thickness of over 100 feet of sand and gravel were observed in the gravel pits in the area. Three municipal wells are within the aquifer. (Camp, Dresser & McKee, 1965)

b. Subsurface Conditions: The site is known as Pudding Hill and is a large ice contact deposit. Marine deposits surround Pudding Hill and are considered as a barrier to recharge from the Bellamy River. Test boring data was not readily obtainable for this site, however three municipal wells exist at this site.

c. Yield Estimate: In a report by Camp, Dresser & McKee (1965) the Bellamy Water Supply Reservoir is located upstream of the aquifer and it is estimated that approximately 22.4 square miles of watershed could be diverted out of 26.6 square miles. Based on this data, correspondence with Vernon Knowlton of the Water Resources Board, State of New Hampshire, and marine deposits surrounding the aquifer, the Bellamy River is not considered a source of induced stream recharge to the aquifer. The safe sustained yield is estimated to be 0.62 mgd.

d. Water Quality: Water quality data in a report by Camp, Dresser & McKee (1965) indicates that the contaminate levels for wells in aquifer DO-2 do not exceed the standards of the Safe Drinking Water Act of (1978).

4. Conclusions and Recommendations

The present wells probably equal or exceed in pumping capacity this report's estimate of the safe sustained yield of the aquifer. Additional test exploration is not recommended at this site.

SITE DU-1, DURHAM, NEW HAMPSHIRE

1. Introduction

Site DU-1 is located at the western edge of Durham and the eastern section of Lee, N.H. The site evaluation consisted of a study of the U.S.G.S. topographic and geologic maps, Phase I report and a site reconnaissance by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.14	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results and Investigations

a. Surficial Conditions: The surficial area of the aquifer is approximately 0.14 square miles. No municipal wells exist on the site. Development in the aquifer is light except for a few residential dwellings.

The aquifer is known as "Spruce Hole" and is a kettle hole surrounded by kames. Gravel and sand pits exist on the site with excavated faces 20-40 feet in height.

Till and marine deposits border the aquifer.

b. Subsurface Conditions: Test well logs by Whitman and Howard (1977) indicate the aquifer has fine sand and gravel to a depth of 79 feet at T.W. 29. Test well T.W. 28 was pumped at 30 gpm from a 2½" diameter test well and showed a specific capacity of 13 gallons per foot of drawdown. The static water levels were 18 feet at T.W. 28 and 12 feet at T.W. 29. Seismic line S-11 indicated a maximum depth of 30 feet at the seismic site (Portsmouth 1977).

c. Yield Estimate: The safe sustained yield is estimated to be 0.1 mgd. The limited yield is due to the assumption that precipitation is the only source of recharge to this site. Also, the aquifer has a limited surficial area.

d. Water Quality: Data on groundwater quality (Whitman and Howard (1977) indicates well T.W. 29 had levels of manganese of 0.17 milligrams per liter (mg/l). Recommended limits are 0.05 mg/l.

4. Conclusions and Recommendations

Additional testing is recommended to determine the extent of the aquifers surficial area and its hydrogeological properties.

SITE EP-1, EPPING, NEW HAMPSHIRE

1. Introduction

Site EP-1 is located in the western section of Epping, N.H. The site evaluation consisted of a study of the U.S.G.S. topographic and geologic maps, the Phase I report and a site Reconnaissance by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.53 mi² Stream Width - 27 ft
Recharge Streams - Lamprey Streambed Area - 210,600 ft²
Streambed Material - Gravel,
 Sand, Silt
Stream Length - 7,800 ft Streambed Infiltration Rate - 5 gpd/ft²

3. Results of Investigations

a. Surficial Conditions: The approximate surficial area of of the aquifer is 0.53 square miles. A municipal well is located east of the aquifer. Well design data indicate the water-bearing material to be only 6 feet in thickness and very limited in pumping capacity and aerial extent. Therefore, this area was not included in the aquifer. The Lamprey flows through the aquifer and is considered hydraulically connected. A gravel pit near Bunker Pond shows exposures of stratified sands and gravel thinly interbedded with clay. The sand and gravel extends down the the Lamprey River. Kettle holes and Kames are found throughout aquifer EP-1.

b. Subsurface Conditions: Test wells by Layne New England Co. (1978) indicate coarse sand and gravel extend to a depth of 42 feet in aquifer EP-1. Static water levels averaged 7 feet. In test well T.W. 6 and T.W. 7, 50 gpm and 75 gpm were pumped respectively.

c. Yield Estimate: Assuming a hydraulic connection exists between the aquifer and the Lamprey River, the estimated safe sustained yield is 1.43mgd.

d. Water Quality: A field test indicated the iron and manganese to be low at T.W.6 and T.W. 7. The reach of the Lamprey River, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class B stream. Class B streams are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Lamprey River.

4. Conclusions and Recommendations

It is recommended to conduct test well explorations adjacent to the Lamprey River.

SITE EP-2, EPPING NEW HAMPSHIRE

1. Introduction

Site EP-2 is located in the eastern section of the Town of Epping, N.H. Investigations consisted of a review of U.S.G.S. topographic and geologic maps, Phase I Report and a site reconnaissance by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.58	Stream Width 30ft/2.5ft
Recharge Streams -	Streambed Area - 105,000ft ² /18,750ft ²
Lamprey, Tributary to Lamprey	
Streambed Material - Sand, Silt/Sand	
Stream Length - 3,500ft/7,500ft	
	Streambed Infiltration Rate 1.6gpd/ft ² 5gpd/ft ²

3. Results of Investigations

a. Surficial Conditions: The surficial area of the aquifer is approximately 0.58 square miles. Development within the aquifer sites is light with a town sanitary landfill located to the west of the aquifer.

A small stream flows through the aquifer and the Lamprey River crosses the eastern edge of the site.

The aquifer appears to be a delta Kame that is built out into marine and fine grained outwash deposits. At the western edge of the aquifer undefined ice contact deposits are found.

b. Subsurface Conditions: Test wells by Layne-New England Co. (1978) indicate the aquifer is at least 61 feet thick (T.W.18) A short pump test on T.W. 18 yielded 208gpm with a 6 foot static water level. Testwells T.W. 1-5 indicated boulders existed in the eastern edge of the aquifer.

c. Yield Estimate: It is assumed that a hydraulic connection exists between the aquifer and the Tributary to the Lamprey River and the Lamprey River. The safe sustained yield is estimated to be 0.68mgd.

d. Water Quality: Data on the groundwater quality of the aquifer was not readily available. The reach of the Lamprey River tributary, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class B stream. Class B streams are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Lamprey River tributary.

4. Conclusions and Recommendations

It is recommended to conduct auger type borings on the eastern edge of the aquifer.

FR-3, FREMONT, NEW HAMPSHIRE

1. Introduction

Site FR-3 is located in the southeastern portion of Fremont, N.H. The site evaluation consisted of a study of U.S.G.S. topographic and geologic maps, Phase I Report, and a site reconnaissance by geotechnical personnel from the Corps of Engineers. A seismic refraction survey was also conducted on the aquifer. (see Appendix F).

2. Physical Characteristics

Aquifer Area - 2.0 mi ²	Stream Length - 5000 ft
	Streambed Area - 125,000 ft ²
Recharge Streams - Exeter River	Streambed Infiltration
Streambed Material - Silt, Sand, Gravel	Rate 5 gpd/ft ²
Stream Width - 25 ft	

3. Results of Investigations

a. Surficial Conditions: The site is approximately 2.0 square miles in area. The Exeter River flows through the southerly portion of the aquifer. The general area within and adjacent to the aquifer site has minimal residential and light industrial development. No sanitary landfills or other environmentally adverse situations were observed on or adjacent to the site. A large portion of this aquifer is covered by Spruce Swamp.

b. Subsurface Conditions: A large Kame Plain lies to the west of the aquifer. Seismic lines 5-1 thru 5-4, indicates the Kame Plain to be of limited thickness and the material to have a low hydraulic conductivity.

c. Yield Estimate: The safe sustained yield for site FR-3 is estimated to 2.06 mgd. The Exeter River is assumed to be hydraulically connected to the aquifer.

d. Water Quality: Data on the groundwater quality for the aquifer was not readily obtainable. However, Spruce Swamp may contribute undesirable iron concentrations under pumping conditions to the aquifer. This reach of the Exeter River, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class B river. Class B rivers are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Exeter River.

4. Conclusions and Recommendations

An exploration program should be conducted to determine the hydrogeological properties of the aquifer. Through the utilization of a well field design, aquifers with saturated thickness of 20 feet or greater may provide municipal water supply.

SITE GR-1, GREENLAND, NEW HAMPSHIRE

1. Introduction

Site GR-1 is located in the central portion of Greenland, N.H. and south of Great Bay. The site evaluation consisted of a review of U.S.G.S. topographic and geologic maps, Phase I Report and a reconnaissance by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.48 mi² Stream Width - None
Recharge Streams - None Streambed Area - None
Streambed Material - None Streambed Infiltration Rate - None
Stream Length - None

3. Results of Investigations

a. Surficial Conditions: The surficial area of the site is 0.48 square miles only. Haines Brook which is less than 1/4 square miles in area comes in contact with the aquifer. Routes 95, and 151 pass through the site. A municipal well is located in the center of the aquifer. The aquifer is a Kame plain (Bradley, 1964) and is bounded by marine deposits.

b. Subsurface Conditions: Test borings were conducted by Whitman and Howard (1977-78) and seismic profiles by Dean (1977) at site GR-1.

At T.W. 7-77 in the northern section of the aquifer approximately 49 feet of sand and gravel was found. A short pump test yielded 75 gpm and had a specific capacity of 112 gallons per foot of drawdown.

In the southern portion of the site Testwell T.W. 76 was drilled to a depth of 72 feet with fine to coarse sand between 42-56 feet. The well test pumped at 50 gpm.

Static water levels ranged from 9 inches at Test Well T.W. 76 to 15 feet at Testwell T.W. 8-77.

An 8-inch diameter well was installed in the state gravel pit in the northern portion of the aquifer and subsequently pumped at 146 gpm with 3 feet of drawdown.

c. Yield Estimate: This aquifer is partially protected against saltwater intrusion by the relatively impervious marine deposits between Great Bay and the site. The estimated safe sustained yield of the aquifer is 0.34mgd.

d. Water Quality Laboratory analysis for T.W. 7A and the 8-inch well indicates iron levels of 0.14 mg/l and medium hardness. However, the test on 8 inch well had a manganese level of 0.9 mg/l which exceeds the State of New Hampshire's safe drinking water limits of 0.05 mg/l.

4. Conclusions and Recommendations

Site GR-1 has been adequately explored in order to define its geohydraulic characteristics.

SITE HA-1, HAMPTON, NEW HAMPSHIRE

1. Introduction

Site HA-1 is located in the northern portion of Hampton with a small segment extending into North Hampton. The site investigations consisted of a review of U.S.G.S. topographic and geologic maps, Phase I Report, and a site reconnaissance by personnel of Anderson-Nichols & Co., inc. Testwell logs were supplied by the Hampton Works Company.

2. Physical Characteristics

Aquifer Area - 0.35 mi^2 Streambed Width - None
Recharge Streams - None Streambed Area - None
Streambed Material - None Streambed Infiltration Rate - None
Stream Length - None

3. Results of Investigations

a. Surficial Conditions: The surficial area of the aquifer is approximately 0.35 mi^2 . The area is highly urbanized in the western section. Four active wells exist on HA-1 and are reported to have a total pumping capacity of 3.80 mgd (Hampton Water Works, 1976). Sewers are being installed in some areas although the majority of homes are still served by septic systems.

This area is partially overlain by marine deposits. (T.W.7-56) and is identified as a Kame plain extending under marine deposits.

b. Subsurface Conditions: Site HA-1 is bounded by fine sands and clays at T.W. 23-60 to the east and T.W. 22-60 to the west. Testwell T.W. 7-56 was driven to a depth of 60 feet with sand and gravel encountered between 18-45 feet. The well was pumped at 60gpm and had a specific capacity of 130 gallons per foot of drawdown. The static water level was 2 feet.

Extensive testing of the aquifer has been conducted by the D.C. Maher Co., for the Hampton Water Works Co.

c. Yield Estimate: The area is not recharged by streams and as a result precipitation is the source of recharge at this site. The estimated safe sustained yield is 0.25 mgd. Present pumpage exceeds this rate, therefore, an undeterminable amount of recharge must be entering the aquifer through lateral groundwater inflow. This recharge is likely to be coming from the northern end of the aquifer.

d. Water Quality: Water quality data listed by the State of New Hampshire (1978) indicates the iron and manganese levels to be less than .01 and .05 mg/l respectively at the existing wells.

4. Conclusions and Recommendations

Additional test explorations should be conducted to the north and east of the aquifer in order to determine the lateral extent of the water bearing sand and gravel.

SITE HA-2, HAMPTON, NEW HAMPSHIRE

1. Introduction

Site HA-2 is located in the northeastern portion of the Town of Hampton, approximately 2,500 feet in distance from site HA-1. The investigations consisted of a review of U.S.G.S. topographic and geologic maps, Phase I Report, and a site reconnaissance by personnel of Anderson-Nichols & Co., Inc. Test Well logs were supplied by the Hampton Water Works Company.

2. Physical Characteristics

Aquifer Area - 0.05	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration
Stream Length - None	Rate - None

3. Results of Investigations

a. Surficial Conditions: The aquifer has a surficial area of approximately 0.05 square miles. The area is heavily urbanized except in the eastern portion near the Hampton Water Works. "Ryder Well." Residential dwellings are the primary development with secondary roads crossing the aquifer. Ice contact deposits are inferred by Bradley (1964) to lie to the west while till is found to the east (T.W. 20-61).

SITE HS-1, HAMPSTEAD, NEW HAMPSHIRE

1. Introduction

Site HS-1 is located in the northeastern corner of Hampstead, N.H. Investigations consisted of a review of U.S.G.S. topographic and geologic maps and a review of the Phase I Report.

2. Physical Characteristics

Aquifer Area - 0.19 mi² Stream Width - None
Recharge Streams - None Streambed Area - None
Streambed Material - None Streambed Infiltration Rate - None
Stream Length - None

3. Results of Investigations

- a. Surficial Conditions: The surficial area of the aquifer is approximately 0.19 square miles and sparsely developed with single dwellings. No municipal wells are located on this site. A small swamp area is located in the eastern portion of the aquifer.
- b. Subsurface Conditions: This area has been mapped as stratified glacial drift by the Corps of Engineers. There is no record of test borings being conducted in the area. Site HS-1 is inferred to consist of saturated sand and gravel deposits bordered by till mantled bedrock hillsides.
- c. Yield Estimate: The estimated safe sustained yield for aquifer HS-1 is 0.14 mgd.
- d. Water Quality: Data on groundwater quality was not readily obtainable for this site.

4. Conclusions and Recommendations

The small surficial area limits the potential development of this site for municipal groundwater supplies.

Additional test explorations are not recommended for this site.

b. Subsurface Conditions: The well log for the Ryder Well indicates sand and gravel extends to a depth of 44 feet. The static water level is 1 foot and the well is reported to have a rated pump capacity of 700 gpm (Hampton Water Works, 1976) and is not pumped continuously.

Test Well T.W. 16-62 encountered fine sand and clay to a depth of 58 feet, south of the aquifer. To the east of the aquifer well logs T.W. 20 and 15-61 indicate till exists with bedrock encountered at 18 feet.

c. Yield Estimate: Recharge to the aquifer is principally from precipitation. However, lateral groundwater inflow to the aquifer may occur through undefined sands and gravels underlying the urbanized area to the west of the aquifer.

The estimated safe sustained yield is 0.04 mgd.

d. Water Quality: Water quality data listed by the State of New Hampshire (1978) indicate the levels of iron and manganese to be 0.21 mg/l and less than 0.05 mg/l respectively.

4. Conclusions and Recommendations

It is likely that actual recharge to the aquifer is higher than estimated. Field investigations should be conducted to determine the hydrogeologic properties of the unconsolidated material adjacent to the western portion of the aquifer.

SITE HU-1, HUDSON, NEW HAMPSHIRE

1. Introduction

Site HU-1 is located in the northwestern side of Hudson, N.H. The site investigation consisted of a study of the U.S.G.S. topographic geologic maps and a site reconnaissance by geotechnical personnel from the Corps of Engineers and Anderson-Nichols & Co., Inc.

2. Physical Characteristics

Aquifer Area - 0.52 mi^2 Stream Width - 5ft/8ft
Recharge Streams - Glover and Merril Brook
Streambed Material - Sand, Streambed Area - $11,000\text{ft}^2/28,800\text{ft}^2$
 gravel, silt Streambed Infiltration Rate 5gpd/ft²
Stream Length - 2,200ft/3,600ft

3. Results of Investigations

a. Surficial Conditions Four wells owned by the Hudson Water Co., are located within this site. The aquifer has been mapped by Koteff (1976) as a large deltaic deposit that was built out into glacial Lake Merrimack. Residential development is extensive around the outer limits of the aquifer. Located in the center of the aquifer is Ottarnic Pond which is a man made recreational pond. The surficial area of the aquifer is 0.52 square miles.

b. Subsurface Conditions: The well log for the Glover Well (Chapman, 1976) indicates sands and gravel extend to a depth of 44 feet in the northern section of the aquifer. Test Well Log for T.W. 7-62 indicates medium sand and gravel encountered to a depth of 47 feet near Little Tarnic Pond and 28 feet of sand and gravel at T.W. 1-78 near Ottarnic Pond. The static water levels in the aquifer range from 1 to 5 ft.

c. Yield Estimate: The existing wells have the pumping capability of approximately 1.6 mgd. Investigations by Anderson-Nichols & Co., Inc. (1980) found that sustained pumpage at this rate has led to the deterioration in the specific capacity of the wells. As a result, the four existing gravel packed wells require frequent rehabilitation in order to meet average daily user demands. The safe sustained yield is estimated to be 0.43 mgd.

d. Water Quality: Laboratory analysis indicates the levels of iron and manganese are as high as 2.3 mg/l and 0.50mg/l respectively at the wells. The high concentration levels at the wells have been attributed by Anderson-Nichols & Co., Inc. (1980) to be infiltration of swamp waters due to over pumping of the aquifer. No water quality information was found for the reaches of Glover and Merrill Brooks which serve as recharge streams for this aquifer.

4. Conclusions and Recommendations

Due to the limited induced recharge potential from the streams and the poor water quality, no further exploration should be made at this site.

SITE HU-2, HUDSON, NEW HAMPSHIRE

1. Introduction

Site HU-2 is located in the western portion of Hudson, N.H. The site investigation consisted of a study of the U.S.G.S. topographic and geologic maps and a site reconnaissance by personnel of Anderson-Nichols & Co., Inc.

2. Physical Characteristics

Aquifer Area - 0.10 mi² Stream Width 8ft/250 ft
Recharge Streams - First Brook, Merrimack River
Streambed Material - Sand, Streambed Area 38,800 ft²
Gravel/Sand, Silt 200,000 ft²
Stream Length - 4,850ft/800ft
Streambed Infiltration Rate 12gpd ft²
1.6gpd ft²

3. Results of Investigations

a. Surficial Conditions: The surficial area of the aquifer is approximately 0.10 square miles. The aquifer has been deeply incised by First Brook with exposures of stratified sands and gravels prevalent along the stream bank. This area is part of a large outwash fan that was built into glacial Lake Merrimack. Heavy residential dwellings border the aquifer with a large sewer force main crossing the western edge of the aquifer. The Hudson Water Co owns an abandoned shallow well field at the eastern edge of the aquifer.

b. Subsurface Conditions: Well log T.W. 7-75 by R. E. Chapman Co., indicates sand and gravel exists between 30-49 feet at this well site. The static water level is 12 feet and the well pumped 50 gpm during a short pump test. It is likely that a hydraulic connection exists between the well site and the Merrimack River.

c. Yield Estimate: Due to approximately 98,208 gallons of induced stream recharge being utilized for HU-1, approximately 370,434 gallons per day is available recharge from First Brook and the Merrimack River. The safe sustained yield is estimated to be 0.44 mgd. Higher yields at this site are likely with more detailed information on the amount of induced recharge available from the Merrimack River.

d. Water Quality: Chemical analysis of T.W. 7-75 indicates moderate levels of chloride (99 mg/l) and iron (0.193 mg/l) exist at the well site. The reach of the Merrimack River, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class C stream. Class C streams are acceptable for recreational boating, fishing, and industrial water supply with or without treatment. No information could be found on iron and manganese concentrations or any other water quality parameters for this reach of the Merrimack River. No water quality information was found for the reach of First Brook which serves as a recharge stream for this aquifer.

4. Conclusions and Recommendations

A detailed investigation on the sanitary radius conditions of the sewer line and residential dwellings should be conducted.

SITE KE-1, KENSINGTON, NEW HAMPSHIRE

1. Introduction

Site KE-1, is located in the central portion of Kensington, N.H. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I Report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers and Anderson-Nichols & Co., Inc.

2. Physical Characteristics

Aquifer Area - 0.66 mi ²	Stream Length - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration
Stream Length - None	Rate - None

3. Results of Investigation

a. Surficial Conditions: The site has a surficial area of 0.66 square miles. The aquifer is a small outwash plain with Kame and Kettle deposits scattered throughout the site. A small bog is located at the northern end with no major streams flowing through the site. The site is moderately developed with residential dwellings.

There are many dug wells in the area that have not gone dry in the memory of local residents. The town dump, which is now closed, is located approximately one mile to the west of this area. A municipal well is located at well log U.S.G.S. K-7.

b. Subsurface Conditions Well logs by the United States Geological Survey indicate coarse sand and gravel extends to a depth of 48 feet at KE-7. Additional testboring data was not

readily obtainable for this site. Due to the numerous Kettle holes found throughout the site, gravels are anticipated to dominate the remainder of the aquifer. Till deposits border the aquifer on the west and marine deposits to the east.

c. Yield Estimate: The safe sustained yield is estimated to be 0.47 mgd. The main source of recharge is through precipitation with aquifer storage providing a buffer during a prolonged draught.

d. Water Quality: Data on groundwater quality is not readily obtainable for the aquifer.

4. Conclusions and Recommendations

Test borings should be conducted in the southwest corner of the aquifer near Lamprey Corners. Also, subsurface investigations should be conducted to more accurately define the northerly extent of the aquifer.

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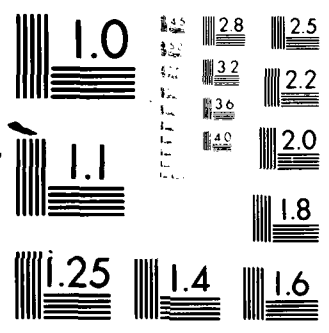
CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2
GROUNDWATER ASSESSMENT STUDY FOR 50 COMMUNITIES IN SOUTHEASTERN--ETC(U)
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SITE KE-2, KENSINGTON, NEW HAMPSHIRE

1. Introduction

Site KE-2 is located in the northern portion of Kensington.

Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase 1 Report.

Reconnaissance of the site was conducted by personnel from Anderson-Nichols & Co., Inc.

This site has been eliminated as an aquifer from the report.

2. Physical Characteristics

Aquifer Area - 0.45	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration
Stream Length - None	Rate - None

3. Results of Investigation

a. Surficial Conditions: The site has a surficial area of 0.45 square miles. A small brook is located to the south with swampland in the north. The area is very lightly developed with farms and residences. There are numerous dug wells which have water level 12 feet below land surface.

b. Subsurface Conditions: Well log U.S.G.S. 15-4 indicated that sands and gravels extend only to a depth of 15 feet at this boring location. This aquifer is estimated on the average to have a thin saturated thickness of 15 feet or less. Additional test borings were not readily obtainable for this site.

c. Yield Estimate: None

d. Water Quality: Data on the groundwater quality is not readily obtainable for this site.

4. Conclusions and Recommendations

It is determined that this site has a shallow depth to bedrock. However, in glaciated terrains, the depth to bedrock changes rapidly and it is possible that significant saturated thickness may be obtained adjacent to this site.

KE-3, KENSINGTON, NEW HAMPSHIRE

1. Introduction

Site KE-3 is located partially in Kensington, South Hampton, and Seabrook, N. H.

Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I Report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Co.

2. Physical Characteristics

Aquifer Area - 0.45 mi ²	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results of Investigations

a. Surficial Conditions: The site has a surficial area of 0.45 square miles. The aquifer is a small outwash plain contiguous with site KE-1. Poorly defined Kames are located in the northern portion with a small Kettle hole situated east of Titcomb Hill. The site is lightly developed with residential dwellings. Four municipal wells are located in this aquifer. The estimated combined pumping capacity of these wells is 1.20 mgd. Two wells (Mill Lane Wells) are located east of the aquifer near Weares Mill. However, they pump at 50 gpm each (Coffin and Richardson, 1979) and have high concentrations of manganese. Also, dogs were buried on the well site in shallow graves and later removed.

These wells are considered by the Town of Seabrook as standby wells. The Weares Mill area appears to be a limited aquifer and was not included in the report aquifer area.

b. Subsurface Conditions: Extensive test borings in 1965, 69, 75-77, and 1978 to locate potential well sites. Test Well 2-75 (Whitman & Howard, 1975-1977) encountered fine to medium sand to a depth of 60 feet. At existing well No. 2, coarse sand and gravel was found to a depth of 55 feet. Static water levels at the wells were 4 ft 8 inches and 1 ft 9 inches respectively. Bordering the aquifer to the west is till (T.W. 54-69) and to the east, fine sands and clay predominates (T.W. 14-55).

c. Yield Estimate: In a report by Coffin and Richardson (1979) Well Nos 1 and 2 have overpumped the aquifer. The water table has dropped from approximately 9 feet below landsurface to between 34 and 38 feet below land surface. Artificial recharge has been proposed for this area. Wells 3 and 4 are limited in combined pumping capacity due to their close proximity (several hundred feet) and resultant well interference.

Precipitation and storage are the primary sources of available water for pumpage. However, and undetermined amount of lateral groundwater inflow may be available to this aquifer as recharge.

It is estimated that the safe sustained yield of this aquifer is 0.32 mgd.

d. Water Quality: Laboratory results for Test Well T.W. 2-75 (Whitman & Howard, 1975-77) indicate that the concentration of manganese (0.15 mg/l) exceeds the Safe Drinking Water Limits of 0.05 mg/l. Test Well T.W. 63-78 indicates concentration of 2.7 mg/l for iron which exceeds the Safe Drinking Water Limits of 0.3 mg/l. Well No.s 3 and 4 (Coffin and Richardson, 1979) are experiencing iron problems and require sequestering methods.

4. Conclusions and Recommendations

Site KE-3 appears to be an aquifer of limited surficial area recharge, recharge and water quality. No further testing is recommended at this site.

SITE KI-1,2,3 KINGSTON, NEW HAMPSHIRE

1. Introduction

Sites KI-1,2,3 are located in the southern part of Kingston, N.H.

Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I Report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - KI-1 0.23 mi²
 KI-2 0.16 mi²
 KI-3 0.26 mi²

Recharge Streams - None
Streambed Material - None

Stream Length - None
Stream Width - None
Streambed Area - None
Streambed Infiltration
Rate - None

3. Results of Investigations

a. Surficial Conditions: The combined total areas of these sites is 0.65 square miles. There are no major streams that can be considered a major source of induced recharge.

There is a possible hydraulic connection between these aquifers and Country Pond which borders the sites.

These areas are lightly developed with individual sewage disposal systems. There are no municipal wells on this site.

b. Subsurface Conditions: The aquifers at Kingston are linear ice contact deposits. However, since there is no record of test boring in this area, no estimation of thickness and lithology can be made. Bradley (1964) indicates marble outwash deposits border the aquifers.

c. Yield Estimate: The only source of recharge for this site is precipitation. The combined safe yield from these sites is estimated to be 0.48 mgd, which is due to the small area and the absence of stream recharge. However, if a hydraulic connection exists between Country Pond and the aquifers, then the larger safe sustained yield may result.

d. Water Quality: No ground water quality data was readily available for this site.

4. Conclusions and Recommendations

These sites need to be investigated more thoroughly using test borings and to further define the hydrogeological parameters and to determine the extent of the hydraulic connection between the aquifers and Country Pond.

SITE LE-3, LEE, NEW HAMPSHIRE

1. Introduction

Site LE-3 is located in the eastern portion of Lee. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.54 mi ²	Stream Length - 1275 ft.
Recharge Streams - Little River	Stream Width - 18 ft.
Streambed Material - Sand and Gravel	Streambed Area - 22,950 ft ²
Streambed Infiltration Rate - 12 gpd/ft ²	

3. Results of Investigation

a. Surficial Conditions: The site has a surficial area 0.54 mi². Little River is the major water body located within the aquifer. No municipal wells exist on the site. Development in the aquifer is moderate with residential dwellings predominating. Gravel and sand pits with excavated faces 20-40 feet high, are found on the site. The aquifer is a high-lying small outwash plain with a deep water table. The United States Geological Survey monitoring well No. 430715N0710047 (see figure 2) has a static water level fluctuating between 30 to 32 feet.

b. Subsurface Conditions: At the U.S.G.S. monitoring wells No. 10 and 11 (Bradley, 1962), sand and gravel was encountered to a depth of 75 and 45 feet respectively. No other well logs existed for

this site. At U.S.G.S. monitoring well No. 430715N0710047 the static water level is approximately 31 feet below land surface. Till borders the aquifer on the east and marine deposits to the south and west.

c. Yield Estimate: The Little River is assumed to be hydraulically connected to the aquifer. Due to bedrock underlying the Little River, the potential induced recharge was reduced 15%. Based on the available induced recharge from the Little River, storage and precipitation, the safe sustained yield is estimated to be 0.66 mgd.

d. Water Quality: Data on the quality of the groundwater were not readily obtainable for this report. This reach of the Little River, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class B River. Class B Rivers are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Little River.

4. Conclusions and Recommendations

Testing borings should be conducted to termine the surficial area and hydrogeological parameters of the aquifer.

SITE LE-4, LEE, NEW HAMPSHIRE

1. Introduction

Site LE-4 is located in the northeastern portion of Lee, New Hampshire. Investigations consisted of a study of the U.S.G.S topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers. This site has been eliminated as an aquifer from the report.

2. Physical Characteristics

Aquifer Area - 0.59 mi ²	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results of Investigations

a. Surficial Conditions: The site has a surficial area 0.59 square miles. Numerous kettle holes are found on the site, such as Turtle Pond. The Oyster River flows adjacent to eastern portion of the aquifer. Residential dwellings are lightly dispersed throughout the area. Sand and gravel pits are predominant in the southeastern section of the site.

b. Subsurface Conditions: Seismic investigations for Portsmouth (1977) indicate the maximum depth to bedrock is 25 feet and 11 feet at seismic lines 5-9 and 5-10 respectively. The unconsolidated

material was estimated to be comprised of dense silt-sand-clay mixtures. Therefore, due to the shallow depth to bedrock and the low permeable unconsolidated material, site LE-4 was eliminated from the study.

c. Yield Estimate: None

d. Water Quality: Data on the groundwater quality is not readily obtainable for this site.

4. Conclusions and Recommendations

No further testing is recommended for this site.

SITE LE-5, LEE, NEW HAMPSHIRE

1. Introduction

Site LE-5 is located in the northwestern portion of Lee, New Hampshire. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.9 mi^2	Stream Width - 7 ft.
Recharge Streams - Oyster River	Streambed Area - $45,500 \text{ ft}^2$
Streambed Material - Sand and Silt	Streambed
Stream Length - 6500 ft.	Infiltration Area - 1.6 gpd/ft^2

3. Results of Investigations

a. Surficial Conditions: The surficial area of the site is approximately 0.9 mi^2 . No municipal wells exist on the site and development in the aquifer is light with residential dwellings predominating. Sand and gravel pits are scattered throughout. Kames and kettle holes are evenly dispersed throughout the aquifer

b. Subsurface Conditions: United States Geological Survey well logs U.S.G.S. 23 and 25 indicate sand and gravel extends to a depth of 56 and 48 feet respectively. The well log for U.S.G.S. 27 shows the depth to bedrock decreases to the north of the aquifer

with very fine sand and silt predominating. A seismic investigation for the City of Portsmouth (1977) indicated that at S-18 15 feet of loose, unsaturated sands and gravels overlies bedrock near well log U.S.G.S. 27. Additional test boring data was not available for this site.

c. Yield Estimate: The estimated safe sustained yield for site LE-5 is 0.72 mgd.

d. Water Quality: Data on the groundwater quality was not readily obtainable for this site. The reach of the Oyster River, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class B River. Class B rivers are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Oyster River.

4. Conclusions and Recommendations

Test borings should be conducted in the central and western portions of the aquifer to verify the aquifer delineation and to determine the hydrogeological parameters.

SITE MA-1, MADBURY, NEW HAMPSHIRE

1. Introduction

Site MA-1 is located in the southeastern portion of Madbury, New Hampshire. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Co., Inc.

2. Physical Characteristics

Aquifer Area - 0.2 mi ²	Stream Width - 6 ft.
Recharge Streams - Johnson Creek	Streambed Area - 21,900 ft ²
Streambed Material - Sand and Gravel	Streambed Infiltration Rate - 12 gpd/ft ²
Stream Length - 3650 ft.	

3. Results of Investigations

- a. Surficial Conditions: Site MA-1 has a surficial area of 0.2 square miles. Four municipal wells are located adjacent to Johnson Creek. Bradley (1964) found that during the summers of 1956 and 1957 pumpage resulted in the creek becoming dry. This indicates that Johnson Creek is hydraulically connected to the aquifer. Johnson Creek bisects the aquifer but was dry during the final visit to the site. The aquifer is identified by Bradley (1964) as a small kame bordered by impervious marine deposits. Residential and industrial developments do not exist at the aquifer.
- b. Subsurface Conditions: The aquifer site was initially developed to supply the city of Portsmouth and Pease Air Force Base. Well

logs (Bradley, 1962) U.S.G.S. 11-14 indicate coarse sands and gravels range in depth from 38 feet to 90 feet. In well log U.S.G.S. 14 42 feet of sandy clay overlies 48 feet of sand gravel and probably receives limited recharge from Johnson Creek. Based on the U.S.G.S. well logs the lateral extent of aquifer is limited.

c. Yield Estimate: In a report by Layne-New England Company (1971) the aquifer site was determined to be a very limited aquifer with the physical capacity to pump much more water than can be sustained. Also, the frequent lowering of streamflow below the streambed of Johnson Creek and the data from Bradley (1964) indicate that MA-1 is being pumped at a rate greater than the average recharge rate. It is estimated that the safe sustained yield at MA-1 is 0.2 mgd. Bradley (1964) estimated that during a warm season the yield of wells in MA-1 may be limited to about 0.66 mgd. The drought conditions of the mid 1960's were not prevailing at that time and his estimate was for a warm season of undefined severity.

d. Water Quality: Water quality data for well U.S.G.S 11-14 (Bradley, 1964) indicates that concentrations of manganese (0.14 mg/l) exceed the safe drinking water limits of 0.05 mg/l. The State of New Hampshire's water quality summary (1978) indicates the manganese levels are below 0.05 mg/l. No water quality information was found for this reach of Johnson Creek (recharge stream).

4. Conclusions and Recommendations

The safe sustained yield estimates for MA-1 may be considered conservatively low. A more detailed study is recommended to determine the extent of recharge from lateral groundwater inflow and other hydrogeological parameters. Additional test borings are not recommended for this site.

SITE MA-3, MADBURY, NEW HAMPSHIRE

1. Introduction

Site MA-3 is located partially in Madbury and Dover, New Hampshire. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 1.1 mi²

Stream Width - None

Recharge Stream - None

Streambed Area - None

Streambed Material - None

Streambed
Infiltration Rate - None

Stream Length - None

3. Results of Investigations

a. Surficial Conditions: The surficial area of the aquifer is approximately 1.1 square miles. The Barbadoes well was placed in operation in 1947 for the City of Dover. The well is normally run at an average rate of 700 gpm and a reported safe yield of over 1000 gpm (Camp, Dresser & McKee, 1965). The Bellamy Reservoir is located west and adjacent to the aquifer. The site area is sparsely developed with residential dwellings and small businesses. There are active gravel pits in the area. Kame and kettlehole deposits are found on the site with Barbadoes Pond being located in a kettle hole depression.

b. Subsurface Conditions: Test borings by Bradley (1962) indicate the underlying material of the aquifer range in texture from very fine sand to gravel. Marine deposits border the aquifer to the east with till mantled bedrock hills on the west. Two U.S.G.S. wells indicate the deposits are from 102 to 190 feet thick.

c. Yield Estimate: In a report by Camp, Dresser & McKee (1965) the Bellamy Water Supply Reservoir, which is located upstream of the aquifer, can divert approximately 84 percent of watershed streamflow. The Water Resources Board of the State of New Hampshire has indicated that the Bellamy Reservoir can possibly during times of high water demands retain all the streamflow of the Bellamy River. As a result, the Bellamy River is not considered a source of induced stream recharge. However, an undetermined amount of water may be induced from storage in the Reservoir. The estimation of induced recharge from ponds and lakes is discussed in the report methodology. It is estimated that the safe sustained yield for MA-3 is 0.79 mgd.

d. Water Quality: Data on the water quality for the Barbadoes well (Camp, Dresser & McKee, 1965) indicates the iron concentration is 0.5 mg/l, while 0.3 mg/l is recommended by the Safe Drinking Water Limit Act.

4. Conclusions and Recommendations

It is recommended that a more detailed investigation of the hydro-

geologic impact of the Bellamy Reservoir be conducted along with additional testing to verify the surficial area of the aquifer.

SITE MI-1, MILTON, NEW HAMPSHIRE

1. Introduction

Site MI-1 is located on the eastern edge of Milton, north of Milton Center. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Co., Inc.

2. Physical Characteristics

Aquifer Area - 0.43 mi ²	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results of Investigations

a. Surficial Conditions: The site is 0.43 square miles in area and has no major streams that can be considered as a source of recharge. The aquifer is an outwash deposit that is bordered by Town House, Milton and Northeast Ponds. Wells located in close proximity to the ponds may receive significant induced recharge. There is light residential and vacation home development at MI-1. The Town of Milton currently obtains its water from Milton Pond. There are two dumps in the vicinity - both west of the delineated area.

b. Subsurface Conditions: There are no records of any test borings

at MI-1 available. As a result, no conclusions about the thickness or lithology of the aquifer can be made. Road cuts indicate poorly sorted sand and gravel exist with cobbles and boulders. This type of material is indicative of ice contact deposits.

c. Yield Estimate: The safe sustained yield is estimated to be 0.31 mgd. However, if a hydraulic exists between the ponds and the aquifers then a higher safe sustained yield may occur.

d. Water Quality: There is no water quality information readily obtainable for this aquifer.

4. Conclusions and Recommendations

Although this site is relatively small, further investigation should be undertaken to determine the hydrogeological parameters and the hydraulic connections if any between the ponds and the aquifers.

SITE NF-1, NEWFIELDS, NEW HAMPSHIRE

1. Introduction

Site NF-1 is located in the eastern portion of Newfield, New Hampshire. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers. This site has been eliminated as an aquifer from the report.

2. Physical Characteristics

Aquifer Area - 1.0 mi ²	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results of Investigations

a. Surficial Conditions: The surficial area of the aquifer is 1.0 square miles and is sparsely developed throughout. The aquifer has a 6000 foot reach adjacent to the Squamscott River and is subject to tidal influence and possibly salt water intrusion. Two municipal wells, located on Barker Street, have a combined yield of 60 gpm and are approximately 26 feet in depth (Newfields, 1976). The site is comprised of a kame terrace with a small gravel pit located near Sharp Hill.

b. Subsurface Conditions: Test borings (Newfields, 1976) indi-

cate that the maximum depth to bedrock in the area was 33 feet and that significant thicknesses of water material were not encountered. In general, fine sands and clay predominated. Therefore, the site NF-1 was determined to have a very limited saturated thickness and low hydraulic conductivity values. As a result, the site was eliminated from the study as an aquifer.

c. Yield Estimate: None

d. Water Quality: Laboratory analysis for a 2½-inch diameter test well indicated no excessive chemical concentrations existed at this well (Newfields, 1976).

4. Conclusions and Recommendations

Due to the limited thickness and lithology characteristics of the site, no further testing is recommended.

SITE NE-1, NEWTON, NEW HAMPSHIRE

1. Introduction

Site NE-1 is located in the southeast corner of Newton, due east of Newton Center. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Co., Inc.

2. Physical Characteristics

Aquifer Area - .7 mi²

Stream Width - None

Recharge Streams - None

Streambed Area - None

Streambed Material - None

Streambed

Infiltration Rate - None

Stream Length - None

3. Results of Investigations

a. Surficial Conditions: Site NE-1 is approximately 0.7 square miles in area and is moderately developed with residential buildings. There is a public water supply well on the southern edge of the area. An old dump closed two years is located northwest of the site at Rowes Corner and a new dump located in the north center part of the aquifer.

b. Subsurface Conditions:

The aquifer is an outwash deposit surrounding a till mantled bedrock nob. A test boring TW-1 by Layne-New England found 16 feet of

hardpan and boulders "till". The surrounding areas consist of sand and gravels poorly sorted with pebble to boulder size clasts. Additional test borings were not readily obtainable for this site.

c. Yield Estimates: The only source of recharge for this site is from precipitation. The safe sustained yield from this aquifer is 0.5 mgd.

d. Water Quality: There is no water quality information readily available for this site.

4. Conclusions and Recommendations

This site needs to be investigated more thoroughly using test borings to further define the hydrogeological parameters.

SITE NE-2, NEWTON, NEW HAMPSHIRE

1. Introduction

Site NE-2 is located in the northwest corner of Newton adjacent to Country Pond. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - .7 mi ²	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results of Investigations

a. Surficial Conditions: NE-2 is approximately 0.70 square miles in area and there are no major streams that can be considered as recharge sources. However, there may be a hydraulic connection with Country Pond and such a connection would affect recharge rates. There is light residential development in this area with individual septic tank sewage disposal systems. The kames are found on the aquifer which is bordered by till mantled bedrock hills.

b. Subsurface Conditions: The aquifer at Newton is a linear ice contact deposit. However, since there is no record of test borings

in this area no estimation of thickness or lithology can be made.

c. Yield Estimate: The only source of recharge for this site is precipitation. The extent of recharge from Country Pond was not evaluated in this report. The safe sustained yield from this aquifer is 0.5 mgd.

d. Water Quality: There is no water quality information readily available for this site.

4. Conclusions and Recommendations

Although the projected safe sustained yield for this site is small, it could provide a significant water supply source if a hydraulic connection exists between Country Pond and the aquifer. Further investigation is needed to delineate the hydrogeologic parameters and investigate the possibility of a hydraulic connection between NE-2 and Country Pond.

SITE NH-1, NORTH HAMPTON, NEW HAMPSHIRE

1. Introduction

Site NH-1 is located in the northwestern portion of North Hampton, New Hampshire. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Co., Inc. Test well logs were supplied by the Hampton Works Company.

2. Physical Characteristics

Aquifer Area - 0.62 mi ²	Stream Width - 12 ft.
Recharge Streams - Winnicut River	Streambed Area - 13,200 ft ²
Streambed Material - Sand and Silt	Streambed Infiltration Rate - 1.6 gpd/ft ²
Stream Length - 1100 ft.	

3. Results of Investigation

a. Surficial Conditions: The site has a surficial area of 0.62 square miles and is moderately developed with residential dwellings. The Winnicut River is adjacent to the northwestern portion of the site and is assumed hydraulically connected to the aquifer. Routes 95 and 151 are the major highways that run through the site. The Crenshaw Well is located in the northern portion of the aquifer and has a rated pump capacity of 700 gpm (Hampton, 1976). There is a stump and trash dump near the golf course. There are numerous dug wells in the area, which have never gone dry in the memory of local residents. Numerous kame and kettle hole ponds are found within the aquifer area.

b. Subsurface Conditions: At test boring TW-6-65 medium to coarse sand and gravel was encountered to a depth of 50 feet. The Crenshaw Well is presently operating at this site. Approximately 55 gpm was pumped from test well T.W.17-64 with fine to medium sand occurring between 34 to 49 feet. At test well T.W.1-77 coarse sand and gravel was encountered to a depth of 56 feet and was pumped at a rate of 60 gpm. The static water levels ranged from 1 ft. 6 inches at T.W. 24-62 to 18 ft. 6 inches at T.W.3-77. The aquifer is bordered by fine sand and clay to the west (T.W. 26-62) and east.

c. Yield Estimate: Based on the available induced recharge from the Winnicut River storate and precipitation, the safe sustained yield of the aquifer is 0.47 mgd.

d. Water Quality: The New Hampshire Water Supply and Pollution Control Commission (1978) indicates the Crenshaw Well has a manganese concentration of 0.1 mg/l and exceeds the safe drinking water limits of 0.05 mg/l. No water quality information was found for this reach of the Winnicut River (recharge stream).

4. Conclusions and Recommendations

A more detailed hydrogeological investigation should be conducted to determine the surficial area and the rate of recharge from lateral groundwater inflow. This data will allow a more accurate determination of the safe sustained yield of the aquifer. This site is considered a major aquifer in the Town of North Hampton.

SITE NM-1, NEWMARKET, NEW HAMPSHIRE

1. Introduction

Site NM-1 is located partially in Lee, Durham and Newmarket, New Hampshire. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Co., Inc.

2. Physical Characteristics

Aquifer Area - 0.64 mi ²	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results of Investigations

- a. Surficial Conditions: The surficial area of the site is 0.64 square miles and is lightly developed with residential properties. Local residents have mentioned that some drilled rock wells have gone dry. A large gravel pit is planned for development in the northwest corner of the area. Numerous kames are found on the site with marine deposits and swamps located to the west, and till mantled bedrock hills to the east. A sanitary landfill is located west of the aquifer near Tuttle Swamp.
- b. Subsurface Conditions: Bradley (1964) reported a spring is located in the southeast quadrant and flows at a rate of 65,000 gpd.

A test boring by the R.E. Chapman Company encountered medium sand and gravel from 26 to 37 feet at test well T.W.1-65. The well was pumped at 70 gpm. A shallow well field has been reported to have been developed at this site. Seismic investigations for the City of Portsmouth (1977) indicated shallow depths to bedrock at seismic lines S-14 and S-13. Seismic lines S-16 indicated glacial till or weathered bedrock lies at a depth of 18 feet at that site.

c. Yield Estimate: A municipal well is located on the western edge of the aquifer. Mr. Ronald Bloom, Superintendent of Water Works, Town of Newmarket indicated the well has a safe yield of 0.29 mgd or 200 gpm. During the fall months of 1980 the water table was steadily declining in the aquifer. Data on the quality of the groundwater was not readily obtainable for this site. The safe sustained yield for NM-1 is estimated to be 0.46 mgd.

d. Water Quality: Data on the quality of the groundwater was not readily obtainable for this site.

4. Conclusions and Recommendations

The aquifer appears to have a limited saturated and unconsolidated thickness. No further investigations are recommended for this site.

SITE NW-1, NORTHWOOD, NEW HAMPSHIRE

1. Introduction

Site NW-1 is located in the western part of Northwood, south of Northwood Lake and east of Pleasant Lake. Investigation consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Co., Inc.

2. Physical Characteristics

Aquifer Area - .45 mi ²	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration Rate - None
Stream Length - None	

3. Results of Investigations

- a. Surficial Conditions: The site is approximately .45 square miles in area and is under moderate vacation home development pressure. Dug wells in the area went dry during the 1960's drought; drilled rock wells have never gone dry. There are no major streams that can be considered as a recharge source. There are two lakes adjoining the aquifer that may have a hydraulic connection with the aquifer. Such a connection may increase the safe sustained yield.
- b. Subsurface Conditions: Test borings were not readily obtainable

for this site. As a result the saturated thickness or lithology could not be determined.

c. Yield Estimates: The only source considered for recharge at this site is precipitation. The extent of recharge from the two lakes was not determined. The safe sustained yield from this aquifer is 0.32 mgd.

d. Water Quality: There is no water quality information readily obtainable for this aquifer.

4. Conclusions and Recommendations

Further investigation should be undertaken to determine the hydro-geological parameters and the hydraulic connections, if any, between Pleasant and Northwood Lakes and the aquifer.

PE-1, PELHAM, NEW HAMPSHIRE

1. Introduction

Site PE-1 is located in the north central portion of Pelham, N.H. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 1.90 sq mi	Streambed Area -
Recharge Streams - Golden Brook,	104,000 ft. ² ; 124,800 ft. ² ;
Beaver Brook, Island Pond Brook	12,500 ft. ²
Streambed Material - Sand, Silt	Streambed Infil-
Stream Length - 13,000 ft.; 20,800 ft.;	tration Rate -
2,500 ft.	1.6 gpd/ft ²
Stream Width - 8 ft.; 6 ft.; 5 ft.	

3. Results of Investigation

a. Surficial Conditions: Site PE-1 is 1.90 square miles in area. There are three streams - Golden Brook, Beaver Brook and Island Pond Brook - that have been considered as recharge sources. Residential dwellings are lightly dispersed throughout. The town dump is located just east of the aquifer. The Town of Pelham has conducted an extensive test well exploration program along Golden Brook. The aquifer is a large outwash plain bordered by till mantled bedrock hills. Fine sand, silt and clay overlie scattered buried ice contact deposits.

b. Subsurface Conditions: The boring log for 8" 1-73 Pelham (1974) shows 46 feet of sands and gravels, which was pumped at a rate of 200 gpm. Test well TW 5-71 encountered up to 44 feet of gravels and fine sands with only occasional traces of clay.

c. Yield Estimates: The sources of recharge for the aquifer are Golden Brook, Beaver Brook, Island Pond Brook and precipitation. The maximum sustained safe yield is estimated to be 1.75 mgd.

d. Water Quality: The 8" well 1-73 was analyzed for chemical concentrations and was found to be within acceptable limits. No water quality information was found for the reaches of Glover and Merrill Brooks which serve as recharge streams for this aquifer.

4. Conclusions and Recommendations

The aquifer has numerous ice contact deposits in the eastern portion of the aquifer that should be examined with test borings. The same effect of the sanitary landfill cover on water quality should also be investigated.

PE-2, PELHAM, NEW HAMPSHIRE

1. Introduction

Site PE-2 is located in the southern part of Pelham, N.H.

Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - .45 mi²

Streambed Area - 108,000 ft²

Recharge Streams - Beaver Brook

Streambed Infiltration Rate - 1.6 gpd/
ft²

Streambed Material - Sand and silt

Stream Length - 9,000 ft.

Stream Width - 12 ft.

3. Results of Investigation

a. Surficial Conditions: Site PE-2 is 0.45 square miles in surficial area. There is one stream - Beaver Brook - that has been considered as a recharge source to the aquifer. The area is moderately developed with residential dwellings on the border of the aquifer and extensive swamp areas are located throughout.

b. Subsurface Conditions: Test Well TW 11-73 Pelham (1974) encountered 16 feet of sand and 38 feet of clay and silt this well did not pump. Test well TW 21 has 78 feet of sand and gravel

with hardpan at 80 feet. Test well TW 8-73 has silts and sands with a 6 foot clay layer at 25 feet. Test well TW 2-73 has 42 feet of sands and gravels and pumped 190 gpm.

c. Yield Estimates: There is a small Esker in the southeast portion of PE-2. The sources of recharge for this aquifer are Beaver Brook and precipitation. The safe sustained yield for this aquifer is 0.5 mgd.

d. Water Quality: Laboratory results from the 8" test well TW 2-73 indicate excessive limits of iron exist at this site. The concentration of iron was 0.98 mg/l which exceeds the recommended limits of 0.3 mg/l. This reach of Beaver Brook which acts as a recharge stream for the aquifer, is designated by the New Hampshire WSPCC as a Class B river. Class B rivers are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of Beaver Brook.

4. Conclusions and Recommendations

Site PE-2 has been extensively explored, however test well explorations should be conducted in the Esker at the south end of the aquifer.

PL-2, PLAISTOW, NEW HAMPSHIRE

1. Introduction

Site PL-2 is located in the eastern portion of Plaistow, N.H. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.71 mi²

Streambed Area - None

Recharge Streams - None

Streambed Infiltration
Rate - None

Streambed Material - None

Stream Length - None

Stream Width - None

3. Results of Investigations

a. Surficial Conditions: The surficial area of the aquifer is 0.71 square miles. The site is moderately developed with residential and commercial buildings. Route 108 runs through the aquifer and no major streams are found on the site. Kames and Kettle holes are scattered throughout the site. Fine grained outwash material borders the north and till mantled bedrock hills to the east and west. Numerous bedrock outcrops exist to the east, immediately north of Smith Road.

b. Subsurface Conditions: Test borings (Plaistow, 1978) were conducted north of the aquifer which resulted in the original Army Corps delineation being reduced in size. Test Well TW 5-77 was driven 18 feet where till was encountered from 18-22 feet. Other test borings confirmed the shallow thickness of this area immediately north of aquifer PL-2. There are no other records of test borings being conducted in the aquifer.

c. Yield Estimate: The safe sustained yield estimate is based on recharge from precipitation and storage and is considered to be 0.51 mgd.

d. Water Quality: Data was not readily obtainable on the water quality of this aquifer.

4. Conclusions and Recommendations

This aquifer should have a high recharge potential from precipitation due to the numerous ice contact deposits that exist on the site. It is recommended that test borings be conducted at selected sites within the aquifer.

PL-3, PLAISTOW, NEW HAMPSHIRE

1. Introduction

Site PL-3 is located in the northern portion of Plaistow, N.H. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.12 mi^2	Streambed Area - $21,700 \text{ ft}^2$
Recharge Streams - Little River	Streambed Infiltration Rate - 12 gpd/ft^2
Streambed Material - Sand and gravel	
Stream Length - 3,100 ft.	
Stream Width - 7 ft.	

3. Results of Investigation

a. Surficial Conditions: The surficial area of the aquifer is 0.12 square miles. The area is moderately developed with residential dwellings, roads and other cultural features. The Little River flows through the aquifer and is considered hydraulically connected to the aquifer. Two gravel pits are actively being mined in the central section of the aquifer. Inspection of the gravel pits show extensive stratified sands and gravels predominate throughout. An Esker trends northwest to southwest through the site. The area is bounded by fine

grained outwash material to the east and west. Numerous bed-rock outcrops exist to the east immediately north of Smith Road.

b. Subsurface Conditions: Seismic investigations by Layne-New England (Plaistow, 1972) indicated that at seismic line S-E, the sand and gravel extended below ground to a limited depth. However, test borings were conducted at TW 15-74 and TW 14-74 (Plaistow, 1978) and found coarse sand and gravel extends to a depth of 21 feet and 19 feet respectively. The static water levels were at 1 foot at the two test wells. At TW 15-74, approximately 50 gpm were pumped for 4 continuous hours.

c. Yield Estimate: The safe sustained yield is estimated to be 0.25 mgd.

d. Water Quality: Laboratory results (Plaistow 1978) found that iron with a concentration of 1.6 mg/l exists at the site. However, a second unspecified well did not have high concentrations of iron. As a result, the long term water quality in the area is questionable. This reach of Little River which acts as a recharge stream for the aquifer, is designated by the New Hampshire WSPCC as a Class B river. Class B rivers are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of Beaver Brook.

4. Conclusions and Recommendations

The aquifer appears to have a limited saturated thickness and aerial extent. Further investigations should be conducted to further evaluate the water quality at this site. Additional test borings should be conducted in the easterly portion of the aquifer in Newton, New Hampshire.

PO-1, 2, 3 PORTSMOUTH, NEW HAMPSHIRE

1. Introduction

Site PO-1, 2 and 3 is located northwest of Portsmouth, partially on Pease Air Force Base adjacent to the New Hampshire Turnpike. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Company, Inc.

2. Physical Characteristics

Aquifer Area - PO-1 - 3.0 mi^2 ;
PO-2 - $.09 \text{ mi}^2$; PO-3 - $.02 \text{ mi}^2$

Streambed Area - None

Recharge Streams - None

Streambed Infiltration
Rate - None

Streambed Material - None

Stream Length - None

Stream Width - None

3. Results of Investigation

a. Surficial Conditions: PO-1, 2 and 3 have a total area of 3.11 square miles, and is heavily developed with residential and commercial properties. A large portion of PO-1 is covered by the main runway at Pease Air Force Base. According to City of Portsmouth Engineer, Thomas Craven, Pease Air Force Base has been dumping Trichloroethylene into the ground for sometime, and contaminated ground water supplies to the extent that several wells have been shutdown - the Sherburne well

field is located on the southerly end of this aquifer and the Booth Fisheries well is located in the northeastern portion of the aquifer.

b. Subsurface Conditions: U.S.G.S. boring 20 Bradley (1962) indicates sand and clay to a depth of 24 feet. U.S.G.S. 24 indicated 39 feet of sand and gravel, and Test Well 25-77 in the southern section of the aquifer had a thickness of 28 feet of sand and gravel. Test Wells 2, 4, 5-77 drilled by the D. L. Maher Co. in the Sherburne Well field, encountered 51 feet of sand and gravel. Each well pumped 60 gpm with a static water level of 5 feet. Test Well 3-77 indicated 44 feet of sand and gravel pumping 50 gpm, with a 5 foot static water level. The Booth Fisheries well, TW 1-70 (D. L. Maher) indicated 50 feet of sand and gravel and was pumped at a rate of 70 gpm, with a static water level of 8.5 feet. This well was later developed and pumped at 1600 gpm for 24 hours with a 12 foot drawdown.

c. Yield Estimates: The only source of recharge at the site is precipitation. The sustained safe yields for the aquifers are 2.16 mgd for PO-1, 0.06 for PO-2, and 0.01 for PO-3, with the total safe yield of 2.23 mgd.

d. Water Quality: Information from the Sherburne well field indicates that some of the wells far exceed the acceptable limits for Fe and Mn. The City of Portsmouth Engineer, Thomas Craven, has also indicated that Trichloroethylene has contaminated wells on Pease Air Force Base.

4. Conclusions and Recommendations

Sites PO-2 and PO-3 have low safe sustained yields due to their limited surficial area. However, lateral groundwater inflow may be of significant recharge. It is recommended that aquifers PO-1, PO-2 and PO-3 be tested further to determine their hydro-geologic parameters. However, the areas which are currently unexplored lie on Pease Air Force Base which may preclude further investigation.

SITE RA-1, RAYMOND, NEW HAMPSHIRE

1. Introduction

Site RA-1 is located in the southwestern portion of Raymond, New Hampshire. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Company, Inc. Test well logs were supplied by Layne New England and the D.L. Maher Company.

2. Physical Characteristics

Aquifer Area - 0.27 mi^2	Stream Width - 25 & 8 ft.
Recharge Streams - Lamprey, Onway Lake Brook	Streambed Area - 180,000 ft. & 21,600 ft ²
Streambed Material - Sand, Silt, Gravel	Streambed Infiltration Rate - 5 gpd/ft ²
Stream Length - 7,200 & 2,700 ft.	

3. Results of Investigation

a. Surficial Conditions: The site has a surficial area of 0.27 square miles and is moderately developed with residential dwellings. The Lamprey River is adjacent to the northern portion of the site and is assumed hydraulically connected to the aquifer. There is a gravel packed well located within the site with a reported safe yield of 500 gpm (Layne New England). In the eastern portion of the town, two large diameter dug wells provide municipal water supply and are approximately 15-18 feet

in depth. Local dug wells have reportedly gone dry during the 1960's drought. There is an uncontrolled chemical waste dump southeast of this site which is discharging highly carcinogenic compounds into the Exeter River.

b. Subsurface Conditions: At test boring No. 2-70, (Raymond, 1969) fine brown sand and small gravel and clay was encountered to a depth of 63 feet. At test well number 4-70 fine to medium brown sand and gravel was encountered to a depth of 28 feet. Approximately 60 gpm was pumped from this test well. At test well number 6-70, fine brown sand and gravel and traces of clay were encountered to a depth of 55 feet. Approximately 40 gpm was pumped from this test well. The static water levels ranged from 1 foot at test well 4-70 to 18 feet at test well 2-70. The aquifer is bordered by till mantled bedrock hills.

c. Yield Estimates: Based on available induced recharge from Lamprey River, storage and precipitation, the safe sustained yield of the aquifer is 1.20 mgd.

d. Water Quality: An analysis of two test wells by the New Hampshire Water Supply and Pollution Control Commission (1972) indicates an iron concentration of less than 0.1 mg/l and a manganese concentration of less than 0.05 mg/l, which do not exceed the safe drinking water limit of 0.3 mg/l for iron and 0.05 mg/l for manganese. This reach of the Lamprey River, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class B stream. Class B streams are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal

of sewage or wastes is acceptable unless adequately treated. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Lamprey River. No water quality information was found for this reach of Onway Lake Brook which serves as a recharge stream for this aquifer.

4. Conclusions and Recommendations

A more detailed hydrologic investigation should be conducted to determine the surficial area and the rate of recharge from the Lamprey River to the aquifer.

SITE RO-1, ROCHESTER, NEW HAMPSHIRE

1. Introduction

Site RO-1 is located in the southern portion of Rochester, New Hampshire. Investigations consisted of a study of the USGS topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Company, Inc.

2. Physical Characteristics

Aquifer Area - 0.4 mi^2	Stream Width - 34 ft.
Recharge Streams - Cocheco	Streambed Area - $11,900 \text{ ft}^2$
Streambed Material - Silt, Sand and Clay	Streambed Infiltration Rate - 1.6 gpd/ft^2
Stream Length - 350 ft.	

3. Results of Investigations

a. Surficial Conditions: The site has a surficial area of 0.4 square miles and is lightly developed with residential dwellings. The Cocheco River is adjacent and a small portion (350 ft) is assumed hydraulically connected to the aquifer. A large sanitary landfill is located in the central portion of the site. The aquifer is generally comprised of kame and kettle hole deposits with fine sands and marine deposits surrounding the aquifer. Bedrock outcrops are found at the southern tip of the aquifer.

b. Subsurface Conditions: The United States Geological Survey well log U.S.G.S. 21 (Bradley, 1962) indicates 90 feet of sand overlying bedrock was encountered at this site. The aquifer is probably separated hydraulically from the Isinglass River to the west. Only a small portion (350 feet) of the Cocheco is assumed hydraulically connected where the river abuts the aquifer.

c. Yield Estimate: Based on precipitation and the Cocheco River recharge the safe sustained yield is estimated to be 0.31 mgd. However, if a larger reach length of the Cocheco River is found to be hydraulically connected, the safe sustained yield will be significantly greater.

d. Water Quality: Data on the quality of the groundwater was not readily obtainable for this report. This reach of the Cocheco River, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class C stream. Class C streams are acceptable for recreational boating, fishing, and industrial water supply with or without treatment. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Cocheco River.

4. Conclusions and Recommendations

If a significant large hydraulic connection could be established with the Cocheco River then a major water supply source may be capable of being developed at this site. However, the sanitary landfill may seriously effect the water quality and its impact on the aquifer should be investigated. Test borings are recommended in the eastern portion of the aquifer.

SITE RO-2, ROCHESTER, NEW HAMPSHIRE

1. Introduction

Site RO-2 is located partially in Rochester and Farmington, N.H. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 10.2 sq. miles	Stream Length - 67,600 ft.
Recharge Streams - Mad River,	Streambed Width - 60 ft.
Cocheco River, Dames Brook	Streambed Area - 4,056,000 ft. ²
Ela River	Streambed Infiltration
Streambed Material - Sand, Silts,	Rate - 1.6 gpd/ft. ²
and Gravel	

Stream widths and lengths combined.

3. Results of Investigations

a. Surficial Conditions: This site is 10.2 square miles in area and is heavily developed with residential, commercial and industrial sites. There is also a sewage treatment plant on the southern edge of the aquifer. The City of Rochester receives its water supply from a surface reservoir located to the west. There are 4 streams that recharge into this aquifer: Mad River, Cocheco River, Ela River and Dames Brook. There are municipal wells with a reported yield of 1.9 mgd at the northern end of the site in the Town of Farmington (Bradley, 1964).

b. Subsurface Conditions: Borings done for the U.S.G.S.

(Bradley, 1962) indicate 26 feet of sand at U.S.G.S.-1.

Testwell 2-73 Farmington, (1973) indicates 51 feet of sand, gravel and silt and was pumped at 50 gpm, with a static water level of 1.0 foot. In the southern part of the aquifer, U.S.G.S.-27 indicates gravel is interbedded with marine clay deposits to a depth of 84 feet. U.S.G.S.-26 consists of 126 feet of interbedded sand, gravel and marine deposits.

c. Yield Estimates: Precipitation and the Cocheco River, Mad River, Ela River and Dames Brook have all been considered as recharge sources for this aquifer. The areas covered by marine deposits have been subtracted when calculating the safe yield. The sustained safe yield for this site is 8.65 mgd.

d. Water Quality: Water quality data for this aquifer indicate that quality is good with Fe and Mn well within limits. The reach of the Cocheco River, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as a Class C stream. Class C streams are acceptable for recreational boating, fishing, and industrial water supply with or without treatment. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Cocheco River. No water quality information was found for these reaches of the Mad River and Dames Brook which serve as recharge streams for this aquifer.

4. Conclusions and Recommendations

Since RO-2 has such a large potential safe sustained yield and has been explored only in the far north and south, additional investigation is recommended to further define the hydrogeologic parameters.

SITE RO-3, ROCHESTER, NEW HAMPSHIRE

1. Introduction

Site RO-3 is located in the eastern portion of Rochester and adjacent to the New Hampshire - Maine State boundary line. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers. A seismic refraction survey and test boring was also conducted. The logs of the test boring may be found in Appendix G. This site has been eliminated as an aquifer from the report.

2. Physical Characteristics

Aquifer Area - 0.49 mi^2	Stream Width - None
Recharge Systems - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration
Stream Length - None	Rate - None

3. Results of Investigations

- a. Surficial Conditions: The surficial area of the site is 0.49 mi^2 and is lightly developed with residential dwellings. Small gravel pits located on the site show well graded sandy gravels. A kame terrace with small kames is located on the site.
- b. Subsurface Conditions: Seismic investigations indicated the depth to bedrock and the saturated thickness was highly variable throughout. However at seismic line S-5 the saturated

thickness was as much as 64 feet thick. A test boring conducted by the Army Corps of Engineers encountered silt and clay to a depth of 23.5 feet. From a depth of 23.5 to 72.4 feet generally fine silty sand was found with thin layers of fine to medium sand. Based on the fine grained materials found at the well site, Site RO-3 was eliminated as an aquifer.

c. Yield Estimate: The estimated safe sustained yield was not determined for this site.

d. Water Quality: Data on the groundwater quality was not readily obtainable for this site.

4. Conclusions and Recommendations

Additional test borings in the northern and southern portions of the aquifer may indicate that water bearing material of sufficient hydraulic conductivity exist. However, based on the test boring Site RO-3 is not considered an aquifer capable of supplying significant yields of water for municipal purposes.

SITE RO-4, ROCHESTER, NEW HAMPSHIRE

1. Introduction

RO-4 is located northeast of Rochester just south of East Rochester. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers along with a seismic refraction survey.

2. Physical Characteristics

Aquifer Area - 0.49 sq. miles	Stream width - 70 ft.
	Stream length - 15,000 ft
Recharge Streams - Salmon Falls	Streambed Area - 1,050,000 ft. ²
River	Streambed Infiltration
Streambed Material - Gravels	Rate - 1.6 gpd/ft. ²
and Sands	

3. Results of Investigations

a. Surficial Conditions: Site RO-4 is 0.49 square miles in area and is moderately to heavily developed in the residential and commercial sites. The Salmon Falls River is considered a source of recharge for this aquifer. A Kame terrace is found on the site along with several Kames.

b. Subsurface Conditions: At the United States Geological Survey well, U.S.G.S.-16 (Bradley, 1962) sand and gravel extends to a depth of 150 feet at the northern end of the aquifer. A seismic investigation by the Army Corps of Engineers south of the aquifer

indicated the saturated thickness was very thin with glacial till found at several feet below the land surface.

c. Yield Estimates: The sources of recharge for this aquifer are precipitation and the Salmon Falls River. The maximum sustained yield for this aquifer is 2.03 mgd.

d. Water Quality: Data on the groundwater quality was not readily obtainable for this site. This reach of the Salmon Falls River, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSIICC as a Class C stream. Class C streams are acceptable for recreational boating, fishing, and industrial water supply with or without treatment. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Salmon Falls River.

4. Conclusions and Recommendations

Test borings are recommended to further determine the hydrogeologic parameters of this aquifer.

SITE RY-1, RYE, NEW HAMPSHIRE

1. Introduction

Site RY-1 is located in the southwestern portion of Rye, New Hampshire.

Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Co., Inc. Test well logs were supplied by D. L. Maher Company.

2. Physical Characteristics

Aquifer Area - 0.08 mi²
Recharge Streams - None
Streambed Material - None
Stream Width - None

Stream length - none
Streambed Area - None
Streambed Infiltration
Rate - None

3. Results of Investigations

a. Surficial Conditions: The site has a surficial area of 0.08 square miles. There are municipal wells on this site which pump at rates above those predicted by the standard methodologies. There also is a sanitary landfill on the site which is due to close in one year.

b. Subsurface Conditions At test boring 4-74, fine brown sand with angular gravels with clay was encountered to a depth of 49 feet. Test well 4-74 pumped 30 gpm with a specific capacity of 180 gpm per foot of drawdown.

At test well 15-74 fine brown sand and some gravel and clay was encountered to a depth of 28 feet.

The aquifer is bordered by loam sand with sharp gravel and clay (Testwell 20-74) on the east and by fine brown sand with broken gravel and clay on the west (testwell 12-74). The static water levels were at 4 feet. The area has been identified by Bradley as a variably thick kame plain bordered by marine deposits.

c. Yield Estimate: Based on available storage and precipitation, the safe yield of the aquifer is 0.06 mgd.

d. Water Quality: The analysis by Coffin and Richardson (1974) indicates that the concentration of iron ranges from 0.02 mg/l to less than 0.1 mg/l and manganese concentration ranges from 0.01 mg/l to 0.05 mg/l which do not exceed the safe drinking water limits of 0.3 mg/l for iron and 0.05 mg/l for manganese.

4. Conclusions and Recommendations

The safe sustained yield for RY-1 may be considered conservatively low. A more detailed study is recommended to determine the extent of recharge from groundwater inflow and other hydrogeological parameters.

SITE RY-2, RYE, NEW HAMPSHIRE

1. Introduction

Site RY-2 is located in the east central portion of Rye, New Hampshire.

Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

This site has been eliminated as an aquifer from the report.

2. Physical Characteristics

Aquifer Area - 2.6 sq mi.	Stream Width - None
Recharge Streams - None	Streambed Area - None
Streambed Material - None	Streambed Infiltration
Stream Length - None	Rate - None

3. Results of Investigations

a. Surficial Conditions: This site is moderately developed with residential homes and is under moderate subdivision development pressure at this time. There are no streams that can be considered as a recharge source for this aquifer.

b. Subsurface Conditions: Drill logs Rye (1974) TW79-41 indicate 14 feet of cobbles, boulders, and sand. Test Well T.W. 79-40 indicates 16 feet of cobbles, boulders, and sand. However, no saturated materials were encountered. T.W. 79-43 indicates 20 feet of compact clays and sands and no saturated materials. Due to the insufficient thickness of saturated material, this site was eliminated as an aquifer.

c. Yield Estimate: No yield estimate was done.

d. Water Quality: There is no data readily available for this site.

4. Conclusions and Recommendations

This site is not considered a municipal aquifer in this report with no further investigation recommended.

SITES SO-1, SO-2, and SO-3, SOMERSWORTH, NEW HAMPSHIRE

1. Introduction

Sites SO-1, SO-2, and SO-3 are located in the southern, central and norther portions of Somersworth, New Hampshire.

Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I Report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - SO-1 - 0.27 mi ²	Stream Width - 85 ft
SO-2 - 0.13 mi ²	2.5 ft
SO-3 - 0.98 mi ²	None

Recharge Streams - SO-1 - Salmon Falls
SO-2 - Tates Brook
SO-3 - None

Streambed Material - Sand, Silt	Streambed Area - 127,500 ft ²
Sand, Silt	2,500 ft ²
None	None

Stream Length - 1,500 ft	Streambed Infiltration
1,000 ft	Rate - 1.6 gpd/ft ²
None	1.6 gpd/ft ²
	None

3. Results of Investigations

a. Surficial Conditions: The surficial area of the sites SO-1, SO-2, and SO-3 are 0.27, 0.13, and 0.98 square miles respectively. Sites SO-1 and SO-2 have light residential dwellings while SO-3 is heavily urbanized in the southern portion of the aquifer. A sanitary landfill is located between sites SO-2 and SO-3. Willard Pond is found within site SO-3 and is classified as a Kettle Hole pond. The pond is not considered a major source of recharge to the aquifer. Tates Brook flows through site SO-2 and with the Salmon Falls River being adjacent to site SO-1. Both water bodies are considered significant recharge sources to each respective aquifer.

The city of Dover has installed the Willard Pond Well (Dover, 1965) south of Willard Pond in site SO-3. The City of Somersworth has installed well No 3 at site SO-2 and Wells No. 1 and 2 at site SO-1. Numerous Kettle holes and small Kames are found throughout the three aquifers. Generally, fine sands and silts of low permeability border the aquifers.

Wells No. 1 and 2 are located in close such close proximity that only one well at a time can be operated, due to pumping interference.

b. Subsurface Conditions: Extensive test borings and seismic investigations have been conducted by the City of Somersworth (Somersworth, 1968) throughout the city limits. Only Test Wells 5-68 and 33-68 encountered significant amounts of water bearing material for municipal well purposes.

Coarse sand and gravel was encountered to a depth of 45 feet and 38 feet respectively at T.W. 5-68 and T.W. 33-68. The static water levels ranged from 1 to 6 feet throughout the City of Somersworth. In general, the seismic and test borings indicate that fine sands and silts and rapidly fluctuating depths to bedrock surround the three aquifer sites. A review of Plate SO-1, SO-2, and SO-3 shows the three well sites trending in a north to south linear fashion which perhaps may indicate that a pre-glacial drainage channel is buried beneath the glacial sediments.

c. Yield Estimate: The safe sustained yield estimates for SO-1 is 0.40 mgd. However, with properly located wells near the Salmon Falls River and a more detailed investigation of the stream bed infiltration potential, a substantial greater safe sustained yield may be obtained. At sites SO-2, and SO-3, 0.10 and 0.70 mgd respectively. The low value for SO-2 is based on the small potential for recharge from precipitation and Tates Brook.

d. Water Quality: High levels of iron and manganese ranging from 1 - 2 mg/l are found at the Willard Pond, Cummings, Smith (Dover, 1965) No. 1, No. 2, and No. 3 wells (Somersworth, 1968). At T.W. 5-68 the level of manganese was 0.44 mg/l, exceeding the safe water drinking limits 0.05 mg/l. The reach of the Salmon Falls River, which acts as a recharge stream for aquifer SO-1, are designated by the New Hampshire WSPCC as a Class C stream. Class C streams are acceptable for recreational boating, fishing, and industrial water supply with or without treatment. No information could be found on iron or manganese concentrations or any other water quality parameters for this reach of the Salmon Falls River. No water quality information was found for the reach of Tates Brook close to SO-2 aquifer.

4. Conclusions and Recommendations

Due to the extensive exploration program previously conducted in the City of Somersworth, additional test borings are not recommended for sites S0-2, and So-3. However, a more detailed investigation should be conducted at site SO-1 to determine further the potential of induced recharge from the Salmon Falls River.

SITE ST-1, Stratham, New Hampshire

1. Introduction

Site ST-1 is located in the southeast portion of Stratham, New Hampshire.

Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I Report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.42 mi²

Streambed Area - None

Recharge Streams - None

Streambed Infiltration

Streambed Material - None

Rate - None

Stream Length - None

Stream Width - None

3. Results of Investigations

a. Surficial Conditions: Sites ST-1 is 0.42 square miles in area and there are no streams that can be considered as a source of recharge. There is a sanitary land fill located within this area. The site is lightly developed with residential dwellings with some developing subdivisions. Open areas and gravel pits are located throughout the site.

The gravel pits are composed of stratified sands and gravels.

b. Subsurface Conditions: Seismic investigations have been performed for the City of Portsmouth (Portsmouth, May, 1977). Seismic line number s-7 indicates a depth to bedrock from 40 to 80 feet, Line S-15 indicates a depth to bedrock from 20 to 30 feet.

Borings completed for the city of Portsmouth (Portsmouth, August, 1977) indicate up to 18 feet of clay at T.W. 14-77, T.W. 16-77 indicates 30 feet of sand and gravel and was pumped at 40 gpm. The static water level is at 10 feet.

The area has been described by Bradley (1964) as a Kame plain surrounded by Marine deposits.

c. Yield Estimates: The only source of recharge for this aquifer is precipitation. The maximum safe sustained yield for this site is 0.30 mgd.

d. Water Quality: No groundwater quality data was readily available for this site.

4. Conclusions and Recommendations

The results of the test borings indicate large amounts of clay exist in the northwestern part of the aquifer.

It is recommended that investigations be confined to the southeast portion of the aquifer to more accurately define the hydrogeologic parameters.

SITE WA-1, WAKEFIELD, NEW HAMPSHIRE

1. Introduction

Site WA-1 is located on the western edge of Wakefield and eastern edge of Brookfield. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from Anderson-Nichols & Co., Inc.

2. Physical Characteristics

Aquifer Area - 1.11 mi ²	Stream Width - 8 ft. 8 ft.
Recharge Streams - Locke Brook Churchill Brook	Streambed Area - 81,600 ft. 105,920 ft.
Streambed Material - Sand, Silt, Gravel	Streambed
Stream Length - 10,200 ft. Locke Brook 13,240 ft. Churchill Brook	Infiltration Rate-1.6 gpd/ft ²

3. Results of Investigations

a. Surficial Conditions: The total area of this aquifer is 1.11 square miles. This site has two streams, Locke Brook and Churchill Brook that are considered as recharge sources. The town dump is located on Route 16 on the eastern edge of the aquifer. Local residents report that local dug wells went dry during the summer of 1979. The area is lightly developed with residential buildings and is bordered with till mantled bedrock hills.

b. Subsurface Conditions: There is no record of any test borings at WA-1 available so that no conclusions about the thickness or

lithology of the aquifer can be made. However, the aquifer is in the form of a small outwash plain, probably consisting of silt, sand and gravel, that was deposited in a deeply incised pre-glacial valley. Therefore, a substantial saturated thickness is likely at this site.

c. Yield Estimates: The recharge sources considered for this site are Churchill Brook, Locke Brook and precipitation. The safe sustained yield for this aquifer is 1.10 mgd.

d. Water Quality: There is no water quality information readily obtainable for this aquifer. No water quality information was found for this reach of Lock and Churchill Brooks (recharge streams).

4. Conclusions and Recommendations

Further investigation should be undertaken to determine the hydrogeologic parameters of the aquifer.

SITE WA-2,3,4,5, WAKEFIELD, NEW HAMPSHIRE

1. Introduction

Site WA-2,3,4,5 is located on the western edge of Wakefield adjacent to Pine River Pond and Great East Lake. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - WA-2 - 0.42 mi. ² ,	Stream Length - None
WA-3 - 0.97 mi. ² , WA-4 - 0.97 mi. ² ,	Stream Width - None
WA-5 - 1.53 mi. ²	Streambed Area - None
Recharge Streams - None	Streambed Infiltration
Streambed Material - None	Rate - None

3. Results of the Investigations:

a. Surficial Conditions: The aggregate total area of these aquifers is 3.89 square miles. The area is lightly developed with residential dwellings. These sites have no major streams that could be considered as a source of recharge. The Pine River has been dammed at the southerly end of the aquifer to form the Pine River Pond at sites WA-4 and WA-5. Aquifers WA-2 and WA-3 are small outwash fans built out into Great East Lake.

b. Subsurface Conditions: There is no record of any test borings at WA-2,3,4,5 available so that no conclusions about the thickness

or lithology of the aquifer can be made. However, Gelatinwait (1951) identifies the Pine River Valley in which sites WA-4 and WA-5 are located as a major source of sand and gravel. The Pine River Esker is located north of the sites in the towns of Ossipee and Effingham. Associated with this esker, are numerous Kettle-holes, Kames, and Kame Terraces. It is likely that significant thickness of saturated sands and gravels are available at the sites.

c. Yield Estimates: The only source of recharge at these sites is precipitation. The safe sustained yields are WA-2 - 0.3 mgd, WA-3 - 0.7 mgd, WA-4 - 0.7 mgd, and WA-5 - 2.0 mgd for a total of 3.7 mgd.

d. Water Quality: There is no water quality information readily available for this site.

4. Conclusions and Recommendations: The large potential yield from these aquifers in the Pine River Esker to the north indicates further on-site investigation should be conducted. Such investigations would define the hydrogeological parameters more accurately and identify any hydraulic connections between the aquifers and the lakes.

SITE WI-1, WINDHAM, NEW HAMPSHIRE

1. Introduction

Site WI-1 is located partially in the Town of Windham, and Town of Londonderry, N.H. Investigations consisted of a study of the U.S.G.S. topographic and geologic maps and a review of the Phase I report. Reconnaissance of the site was conducted by geotechnical personnel from the Corps of Engineers.

2. Physical Characteristics

Aquifer Area - 0.68 mi. ²	Stream Width - 6 ft.
Recharge Streams - Beaver Brook	Streambed Area - 69,000 ft. ²
Streambed Material - Silt and Sand	Streambed Infiltration
Stream Length - 11,500 ft.	Rate - 1.6 gpd/ft. ²

3. Results of Investigations:

- a. Surficial Conditions: The site is approximately 0.68 square miles in area. Beaver Brook is considered the only large stream capable of supplying induced recharge to the aquifer. It is assumed that individual wells and septic systems are utilized at this site as no indication of a sewage system or municipal water supply is evident. It is located in a narrow valley which is bordered by till mantled bedrock controlled hills.
- b. Subsurface Conditions: The aquifer is on outwash plain with no record of test boring being conducted in the area. As a result, the saturated thickness or lithology could not be estimated.

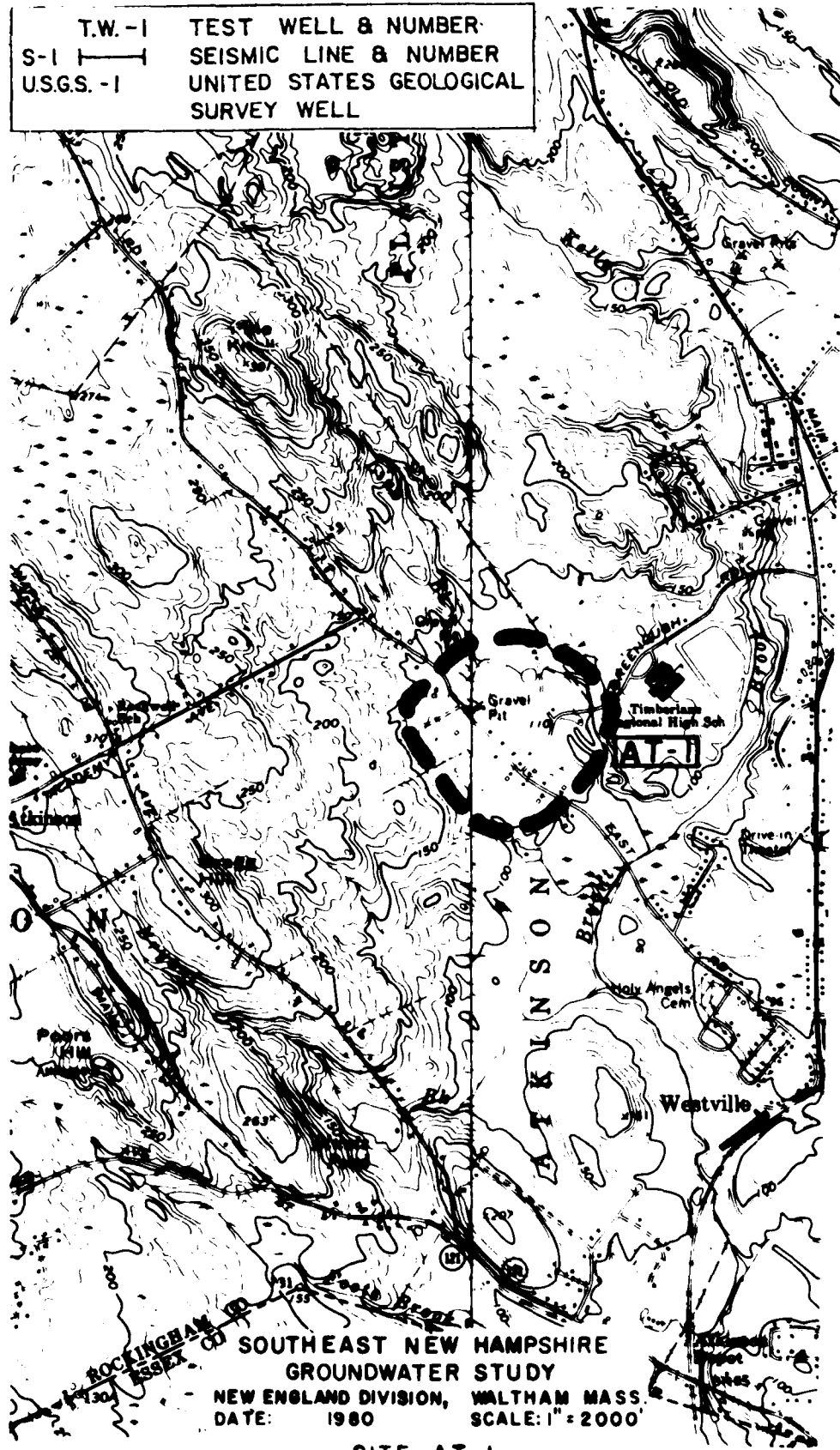
c. Yield Estimate: Based on the available induced recharge from Beaver Brook, storage, and precipitation, the safe sustained yield for WI-1 is estimated to be 0.60 mgd.

d. Water Quality: No groundwater quality data was readily obtainable for this site. This reach of Beaver Brook, which acts as a recharge stream for this aquifer, is designated by the New Hampshire WSPCC as Class C stream. Class C streams are acceptable for recreational boating, fishing, and industrial water supply with or without treatment. No information could be found on iron and manganese concentrations or any other water quality parameters for this reach of Beaver Brook.

4. Conclusions and Recommendations

It is recommended that site investigations be conducted to determine the aquifer saturated thickness and to better define its aerial extent.

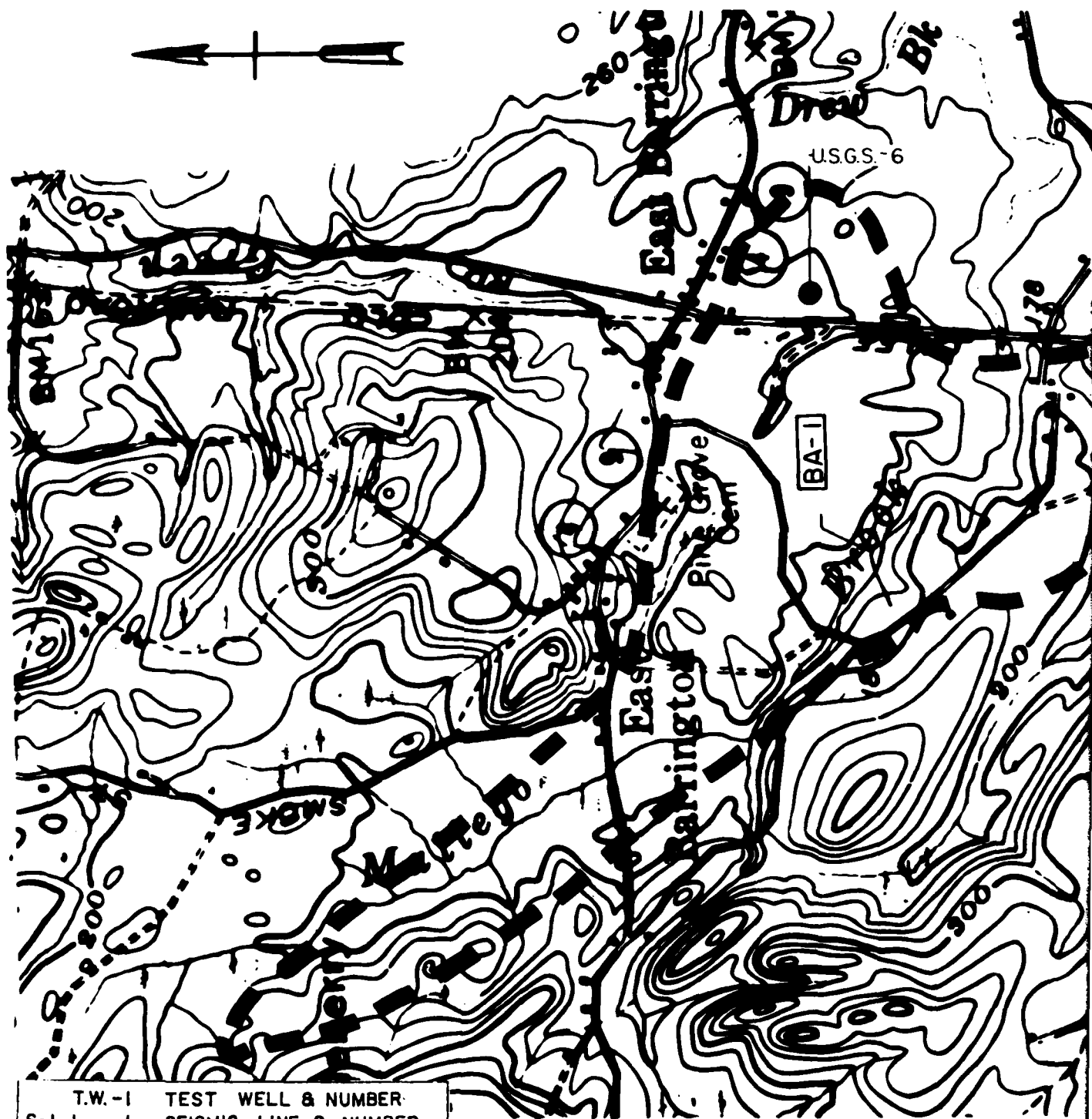
T.W. -1	TEST WELL & NUMBER
S-1	SEISMIC LINE & NUMBER
U.S.G.S. -1	UNITED STATES GEOLOGICAL SURVEY WELL



**SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY**
NEW ENGLAND DIVISION, WALTHAM MASS.
DATE: 1980 SCALE: 1" = 2000'

SITE AT-1

PLATE-1 AT-1



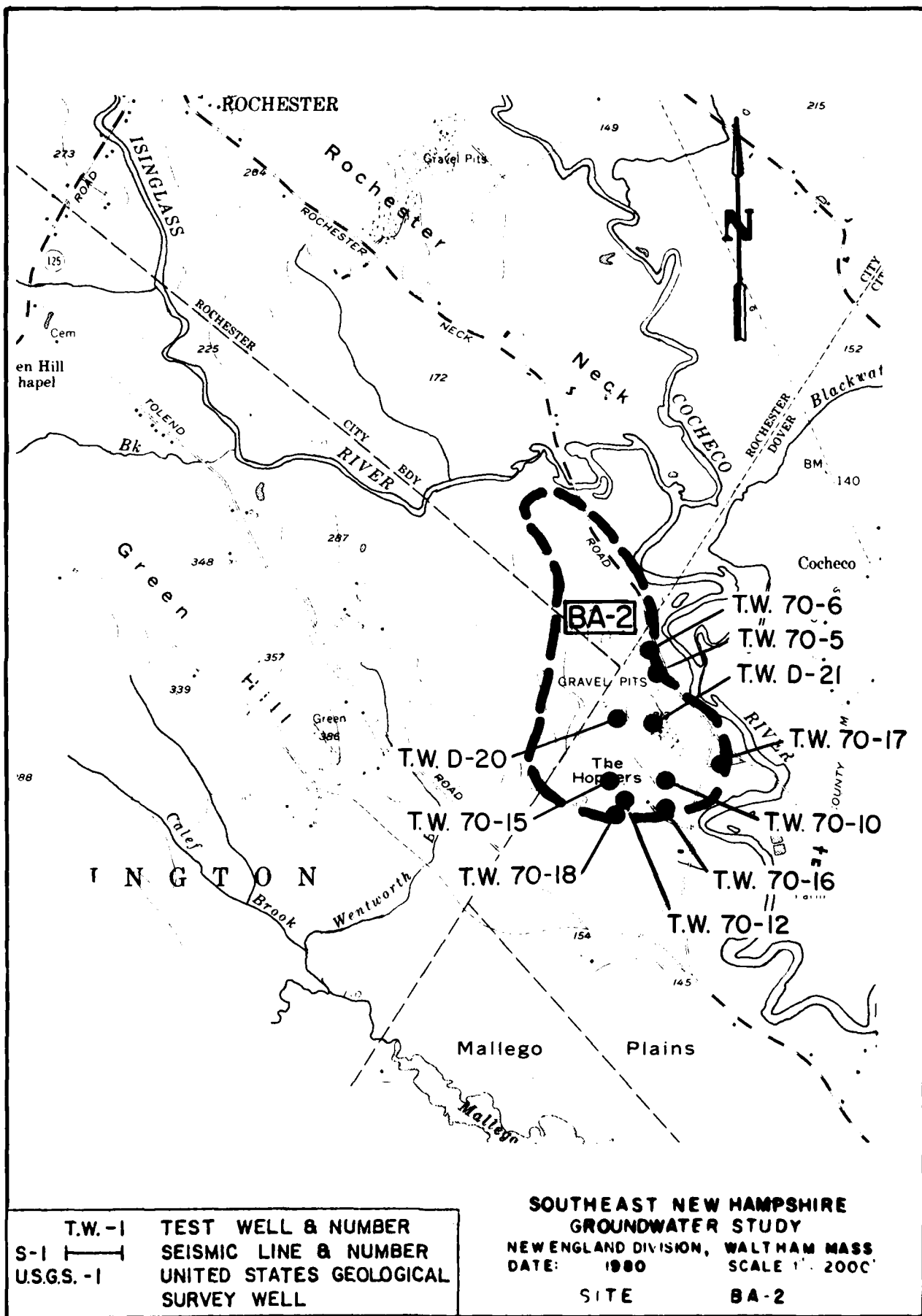
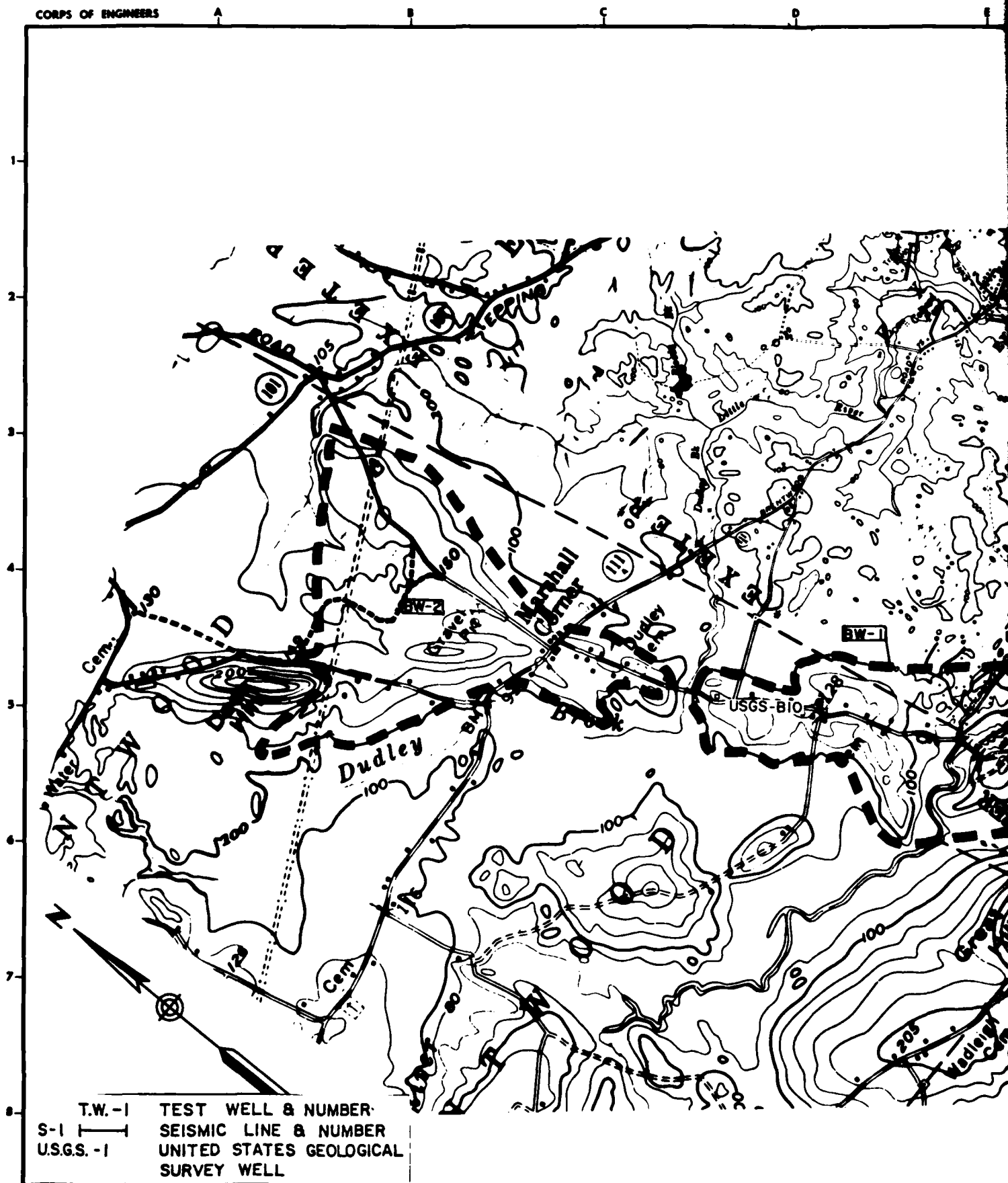
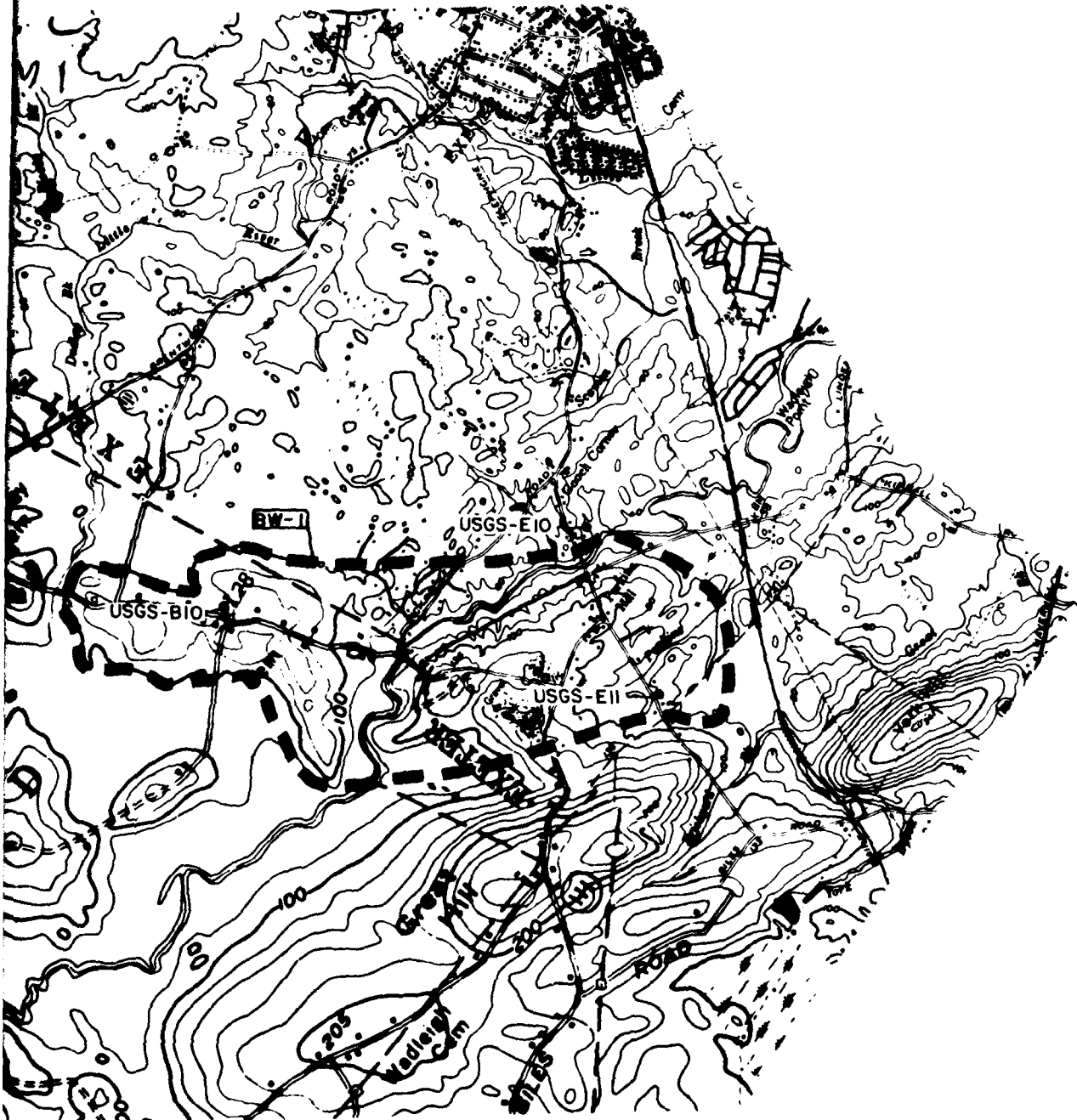


PLATE-1 BA-2





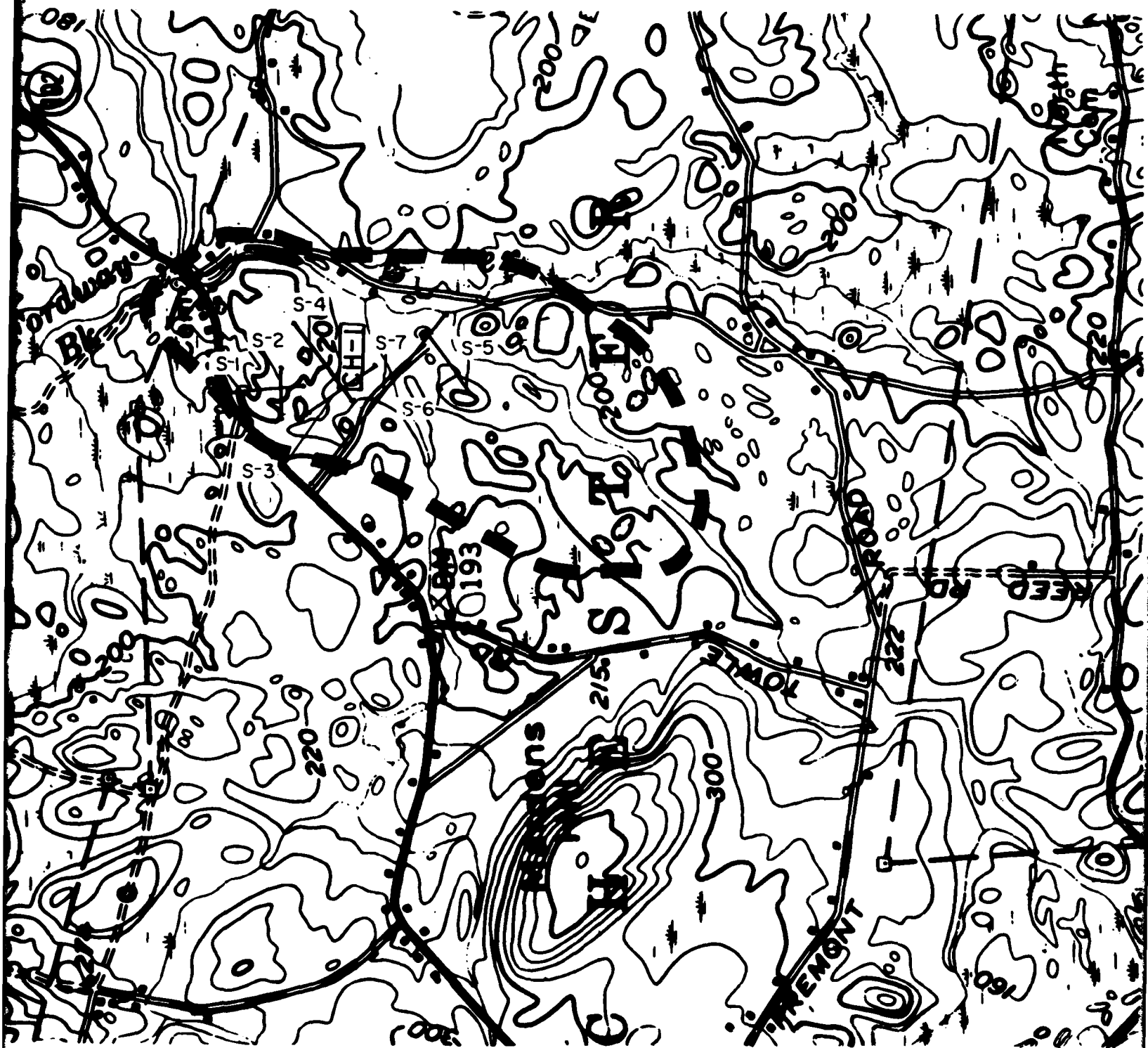
SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS
DATE: 1980 SCALE: 1" = 1000'
SITE: BW-1, BW-2

PLATE-1 BW-1, BW-2

2



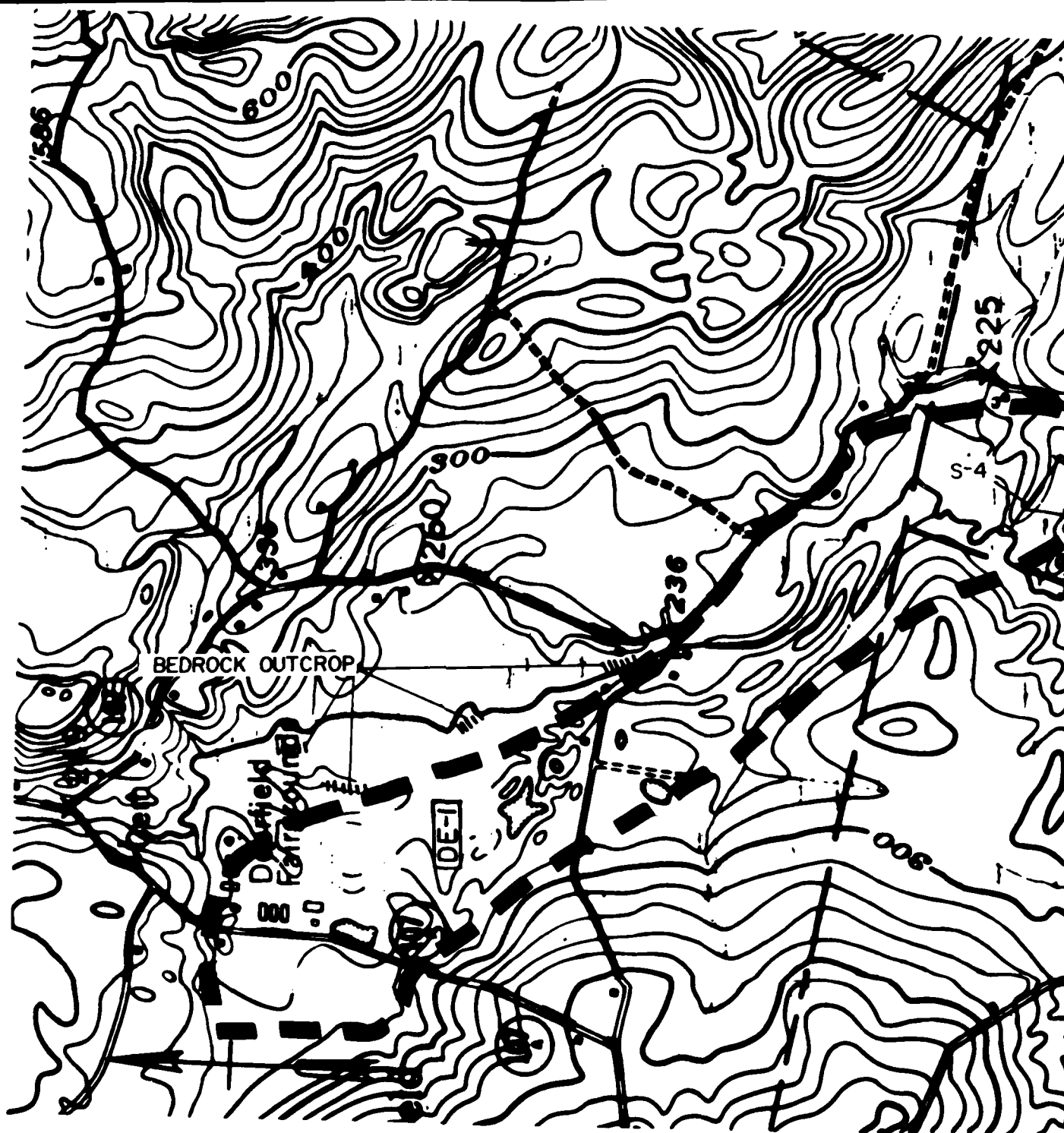
T.W. -	TEST WELL & NUMBER
S-1	SEISMIC LINE & NUMBER
U.S.G.S. -	UNITED STATES GEOLOGICAL SURVEY WELL



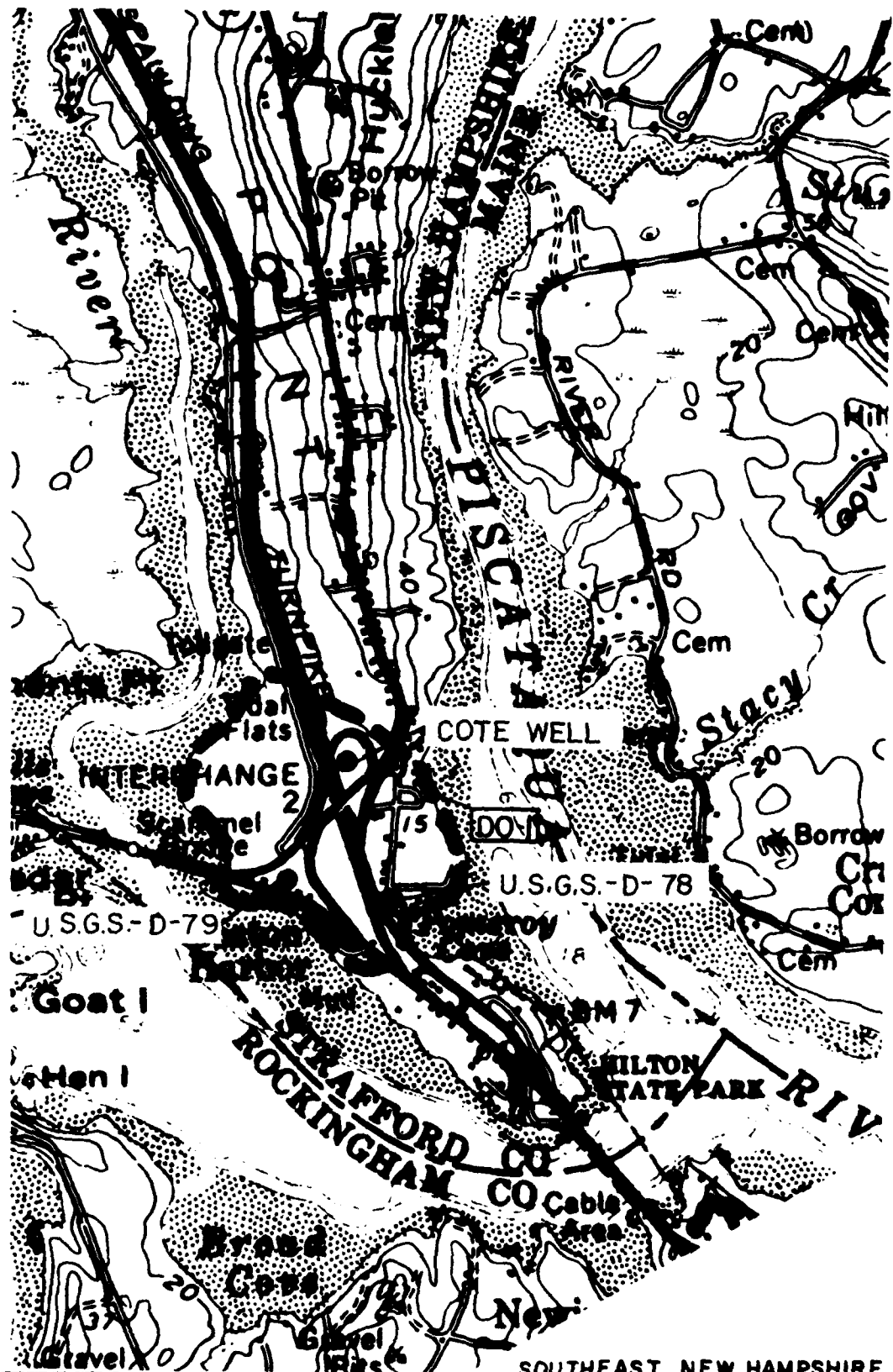
NUMBER
NUMBER
OLOGICAL

SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS,
DATE: 1980 SCALE: 1" = 1000'
SITE CH-1

PLATE-1 CH-



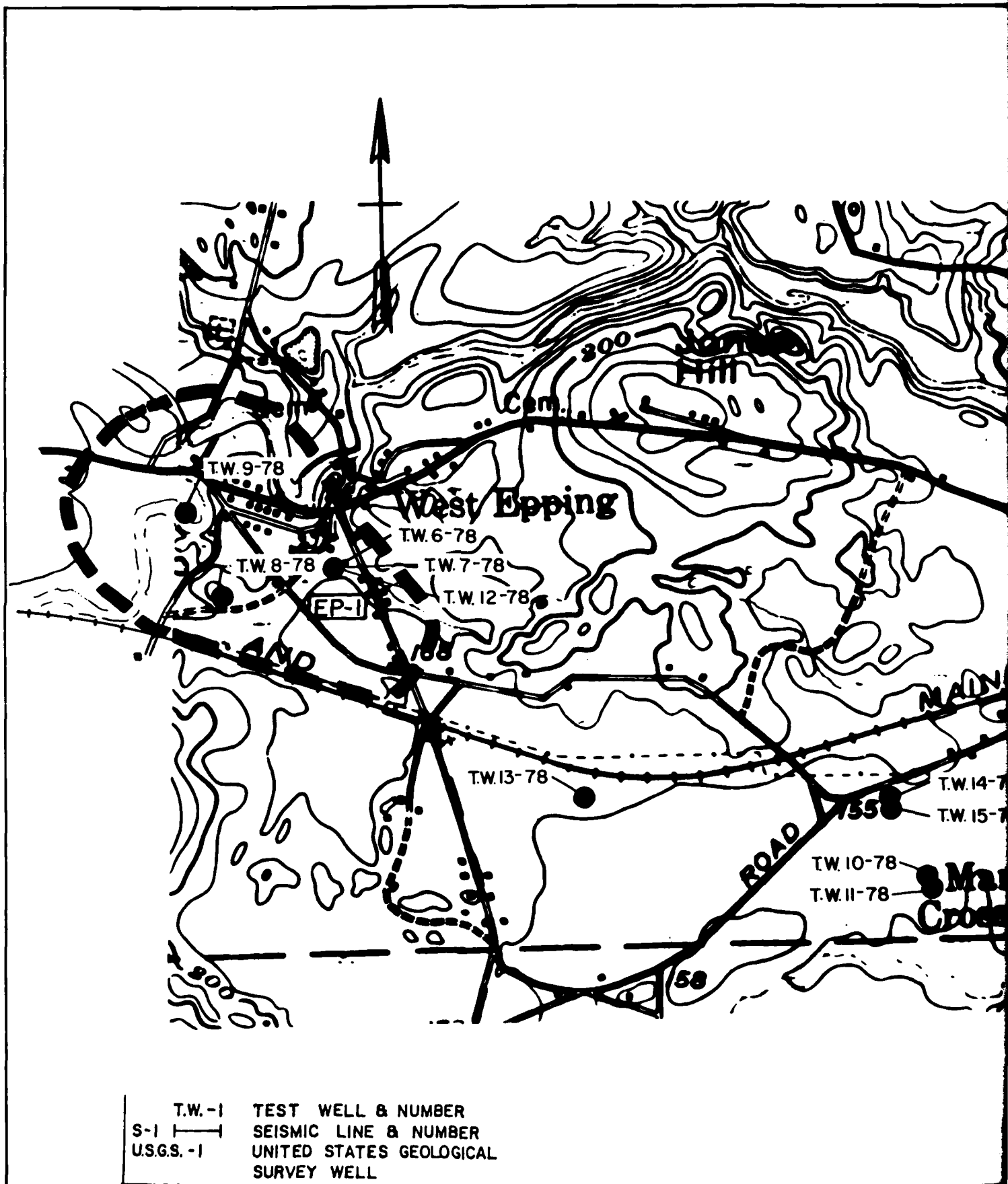
T.W. - 1	TEST WELL & NUMBER
S-1	SEISMIC LINE & NUMBER
U.S.G.S. - 1	UNITED STATES GEOLOGICAL SURVEY WELL

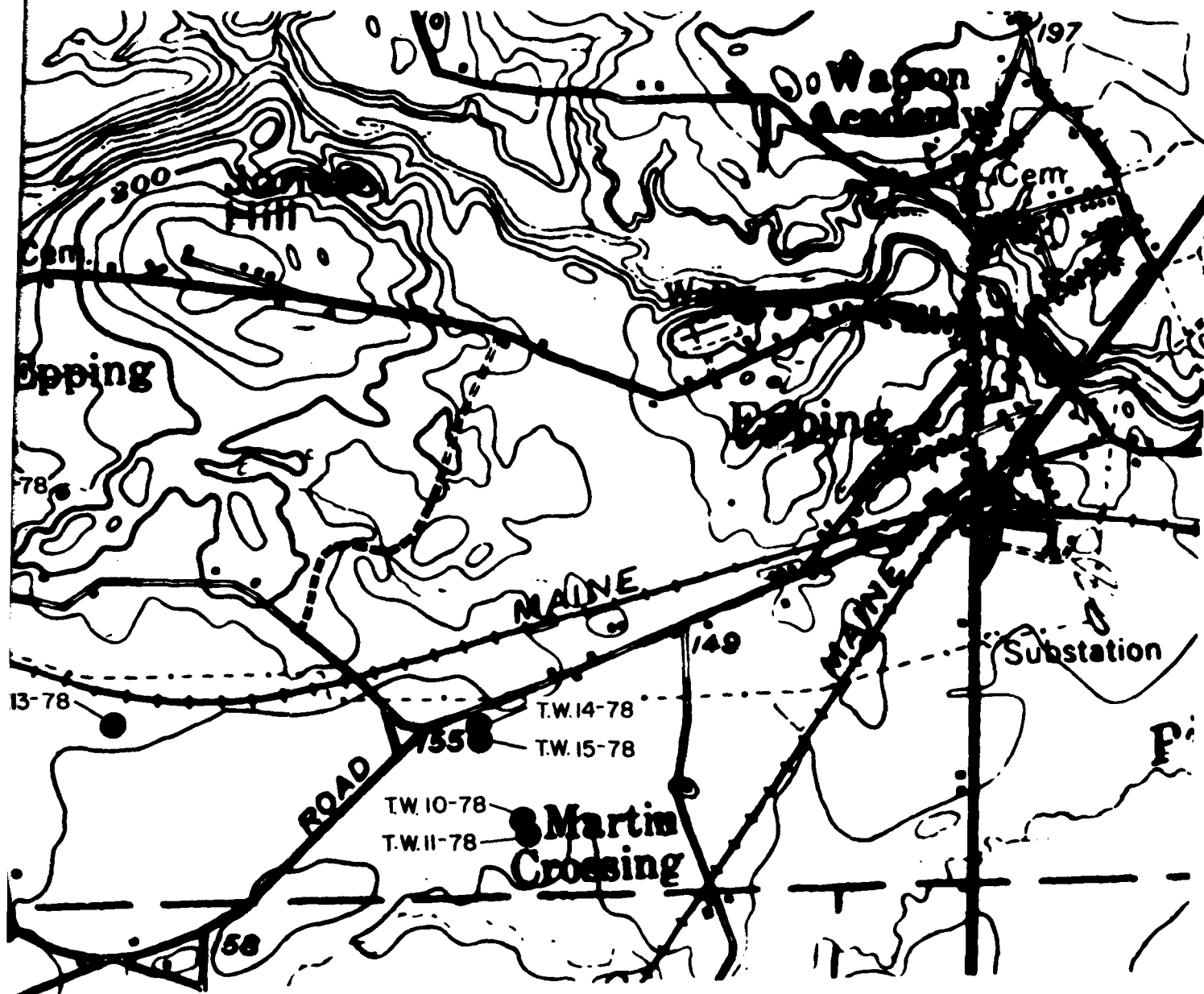


T.W. - I	TEST WELL & NUMBER
S-1	SEISMIC LINE & NUMBER
U.S.G.S. - I	UNITED STATES GEOLOGICAL SURVEY WELL

SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS.
DATE: 1980 SCALE: 1" = 2000'
SITE DO-1

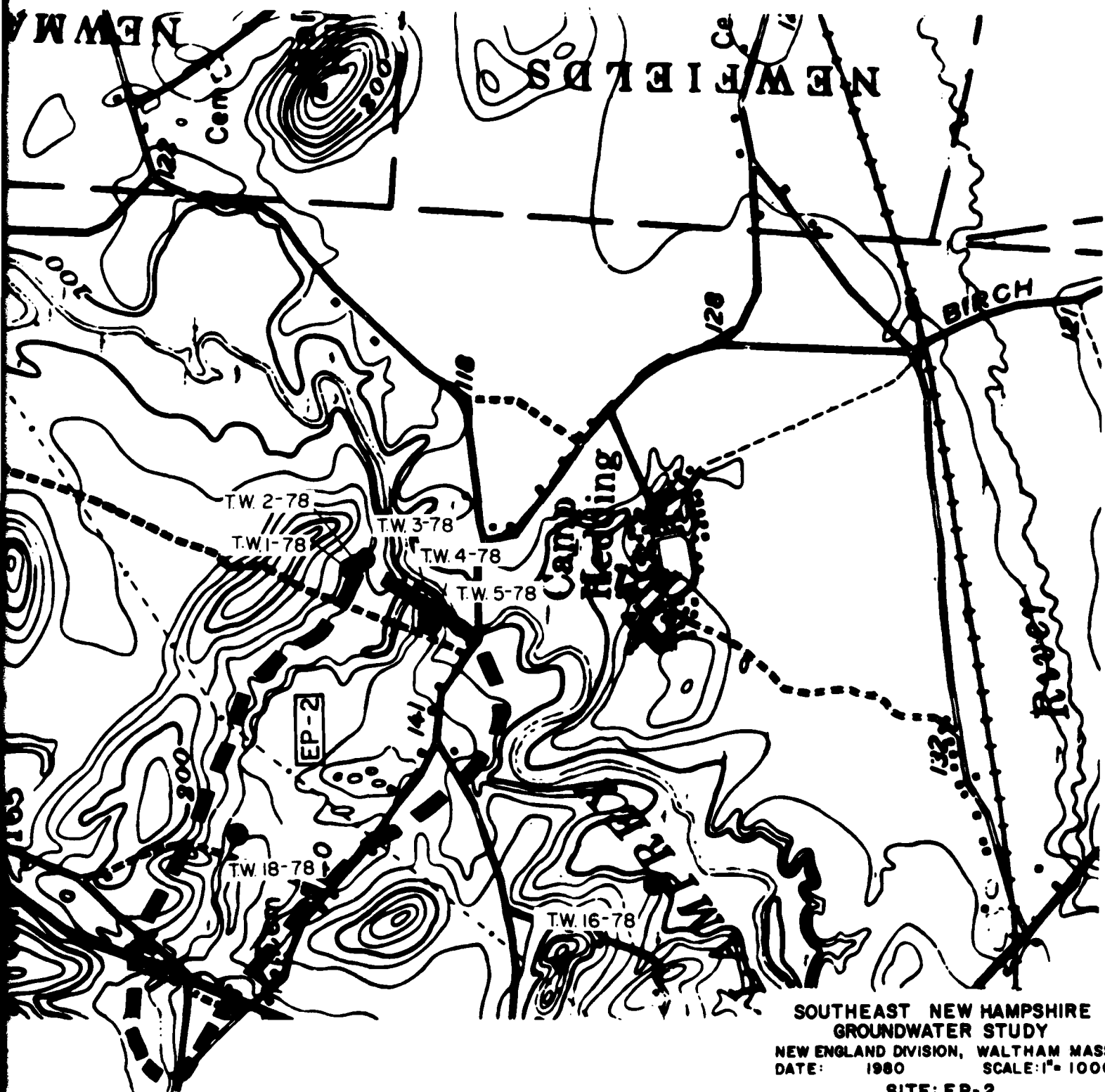
PLATE-1 DO-1





SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM, MASS
DATE: 1980 SCALE: 1" = 100'
SITE EP-1

PLATE-1 EP



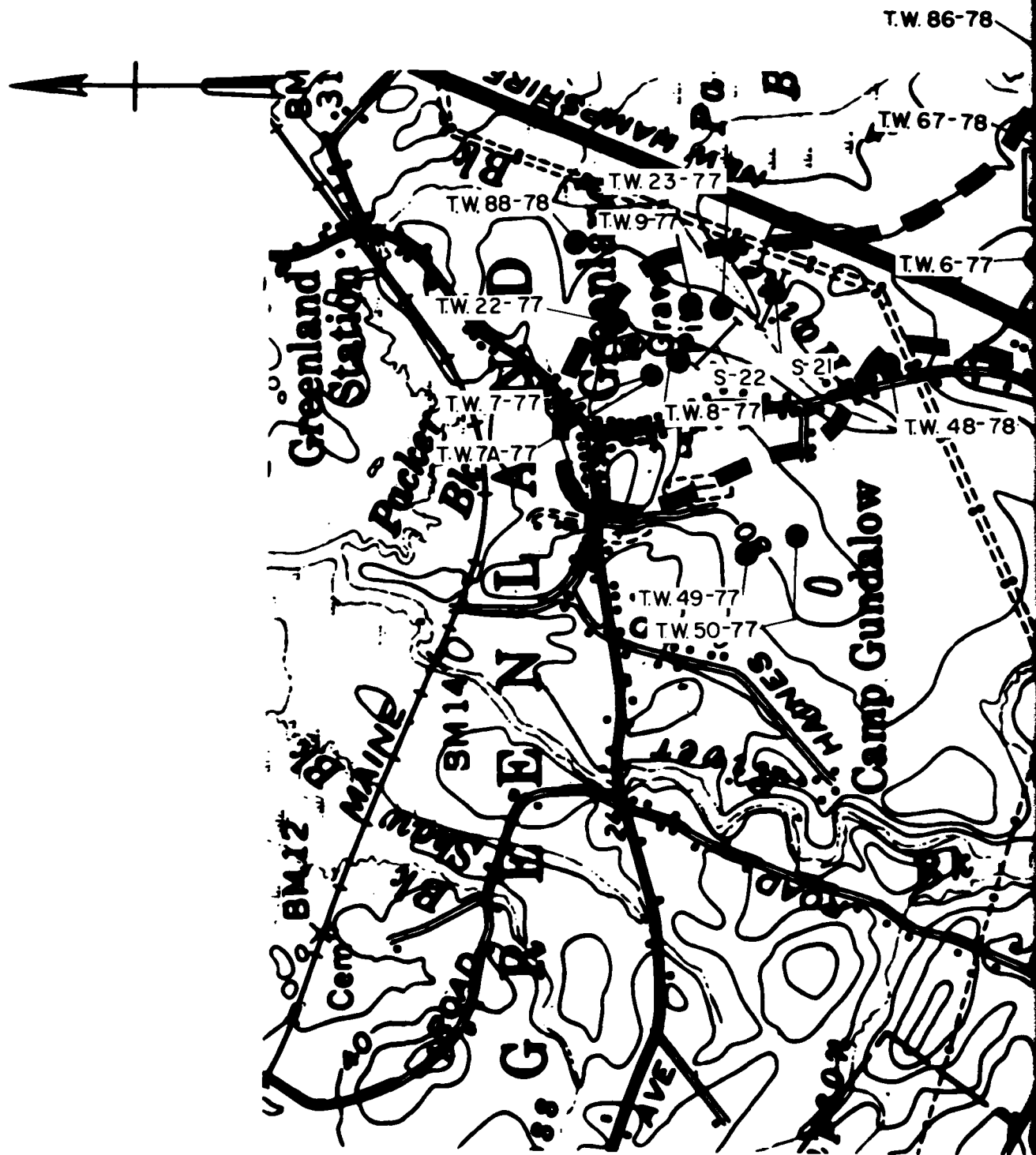


T.W.-1	TEST WELL & NUMBER
S-1	SEISMIC LINE & NUMBER
U.S.G.S.-1	UNITED STATES GEOLOGICAL SURVEY WELL

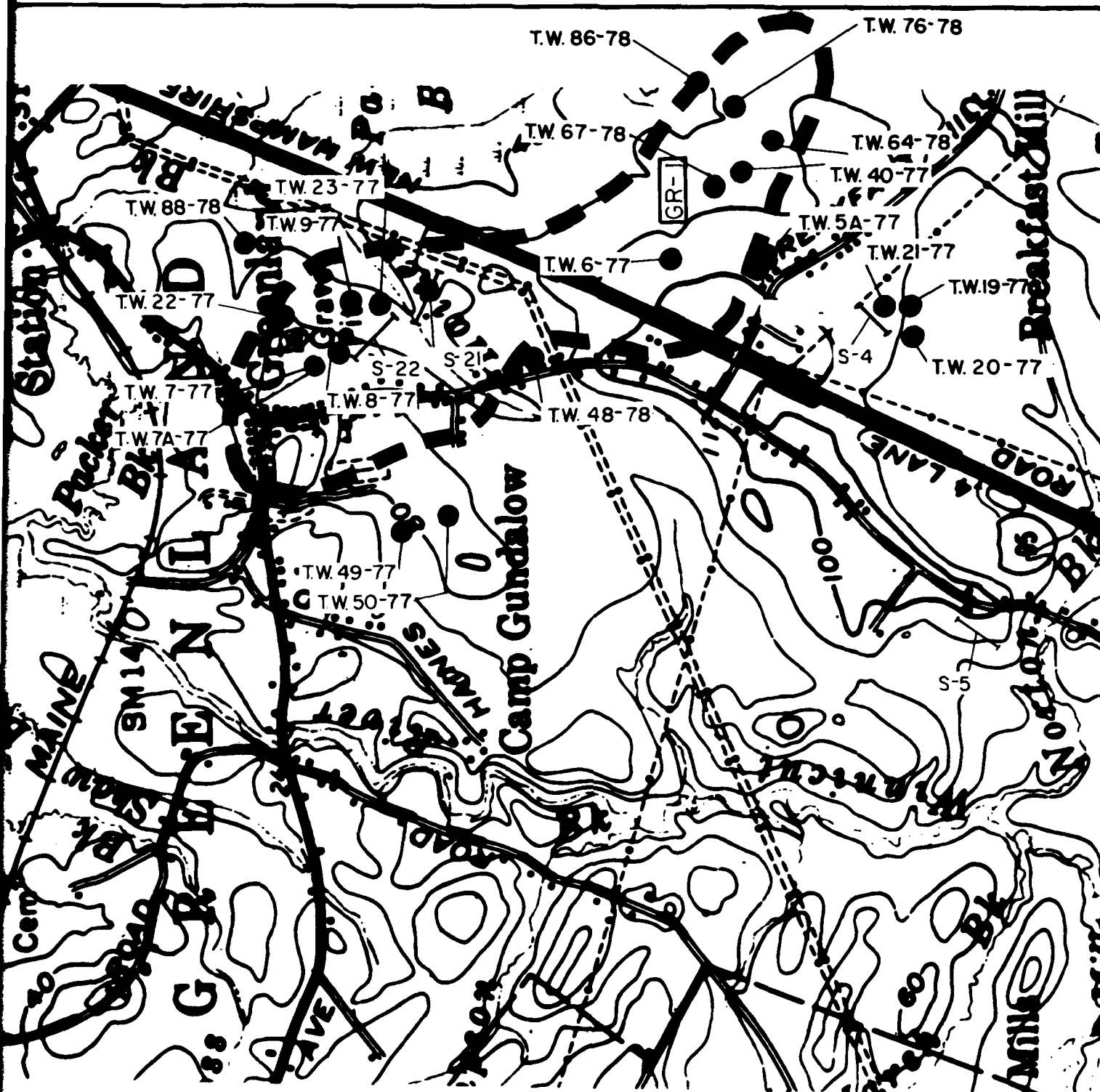


SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS.
DATE: 1980 SCALE: 1" = 1000'
SITE FR-3

PLATE-1 FR

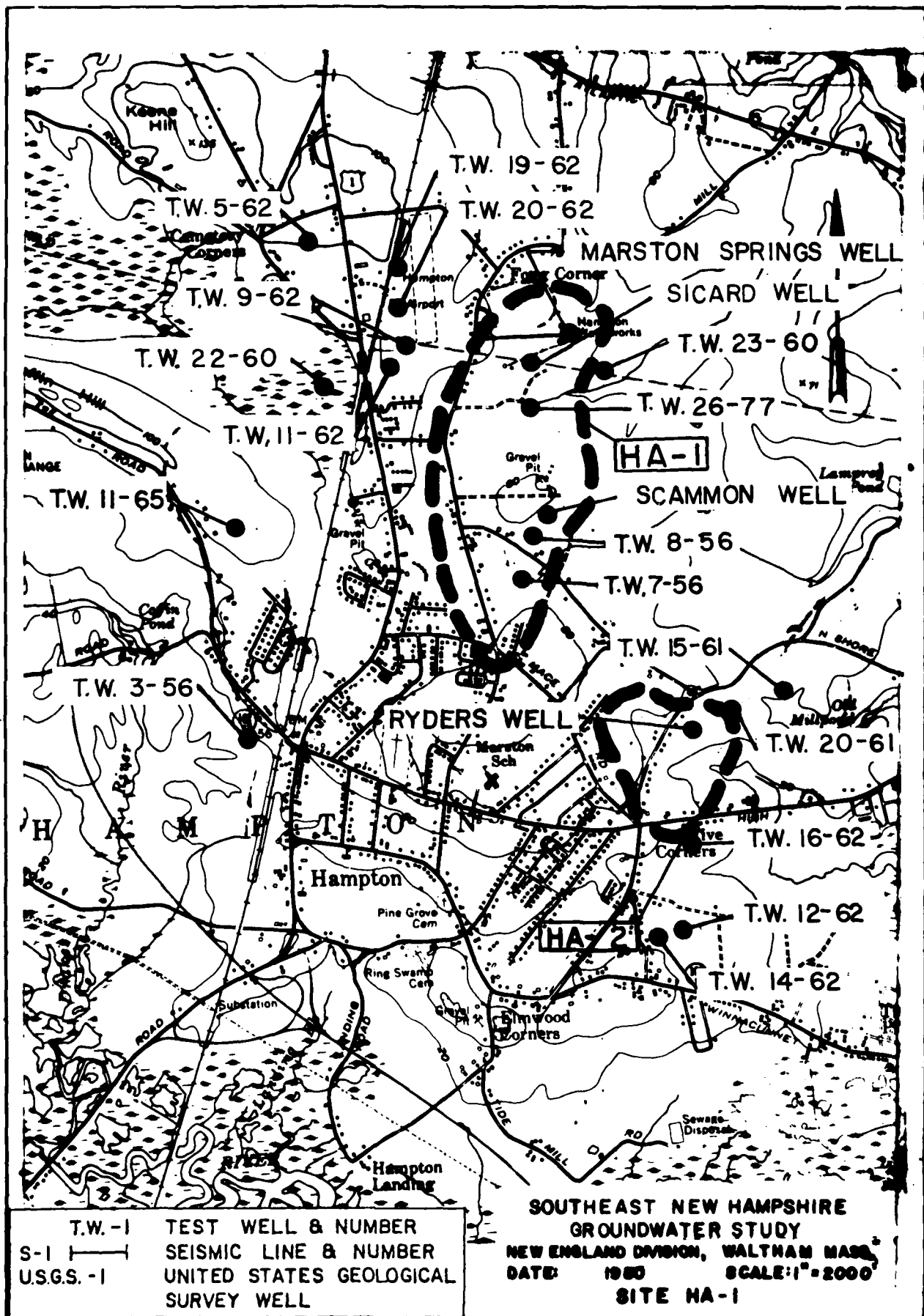


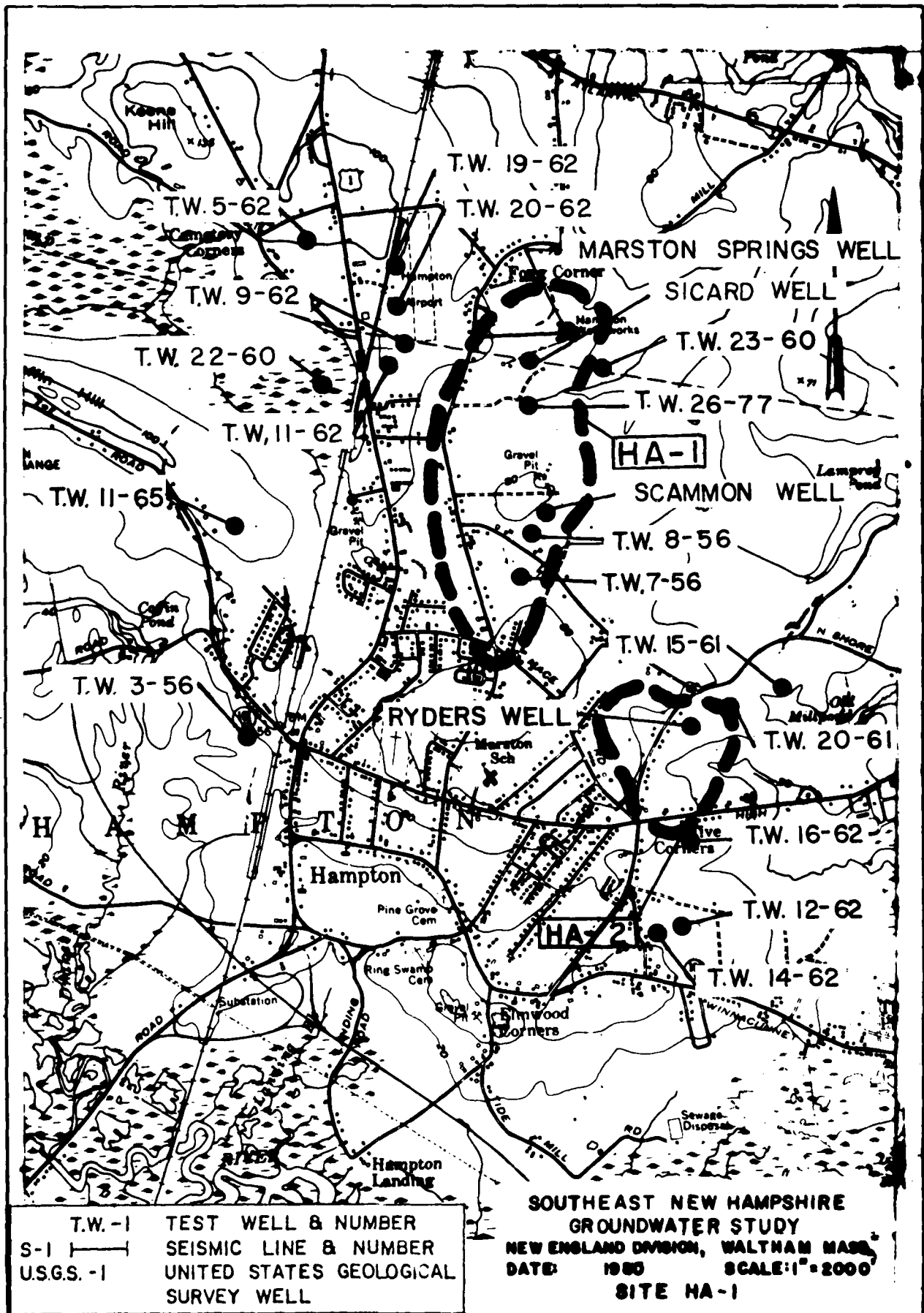
T.W. -1 TEST WELL & NUMBER
 S-1 SEISMIC LINE & NUMBER
 U.S.G.S. -1 UNITED STATES GEOLOGICAL SURVEY WELL

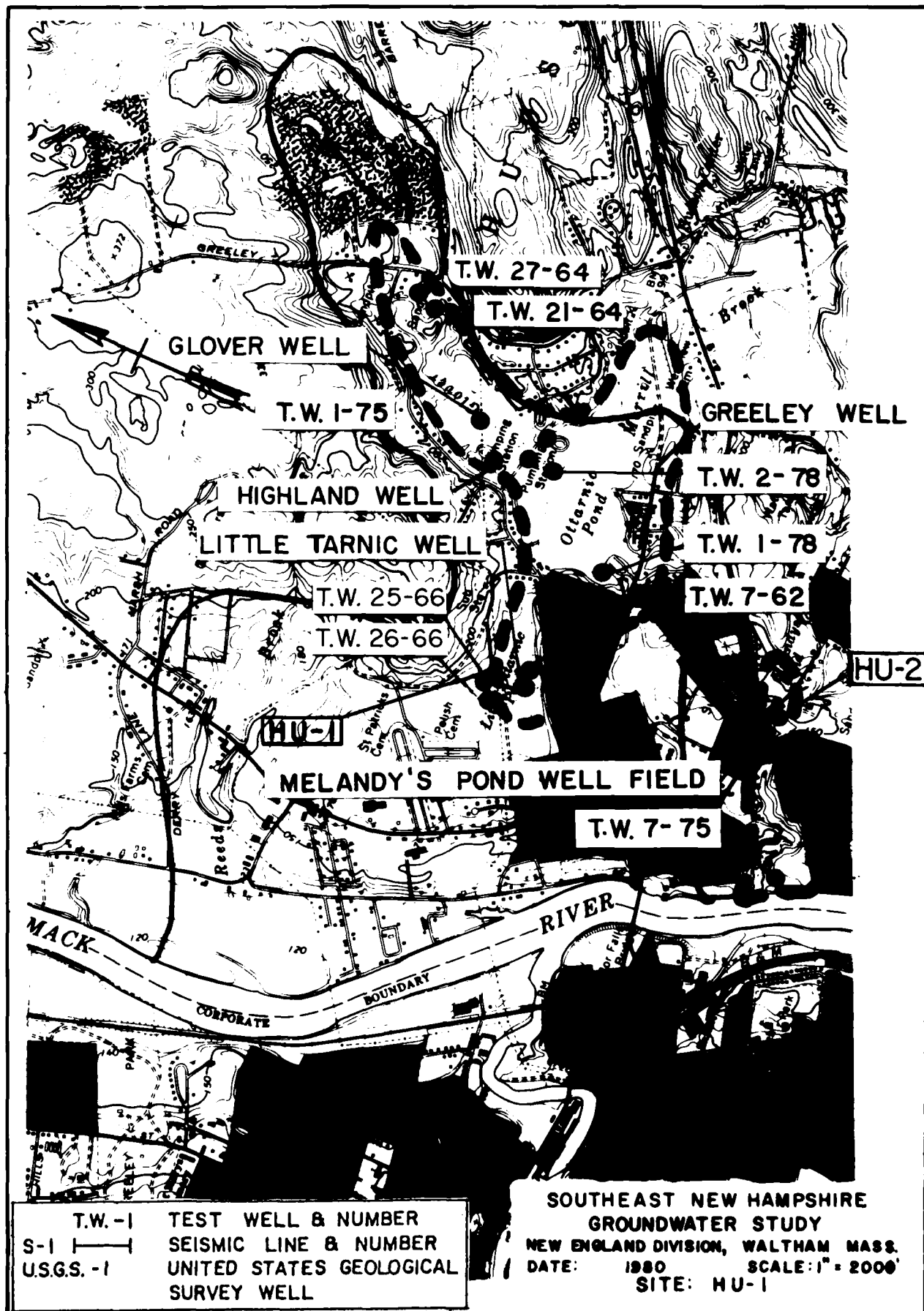


T.W. -1 TEST WELL & NUMBER
 S-1 SEISMIC LINE & NUMBER
 S-1 UNITED STATES GEOLOGICAL SURVEY WELL

SOUTHEAST NEW HAMPSHIRE
 GROUNDWATER STUDY
 NEW ENGLAND DIVISION, WALTHAM MASS.
 DATE: 1980 SCALE: 1" = 1000'
 SITE: GR-1







AD-A098 816

CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV
GROUNDWATER ASSESSMENT STUDY FOR 50 COMMUNITIES IN SOUTHEASTERN--ETC(U)
SEP 80

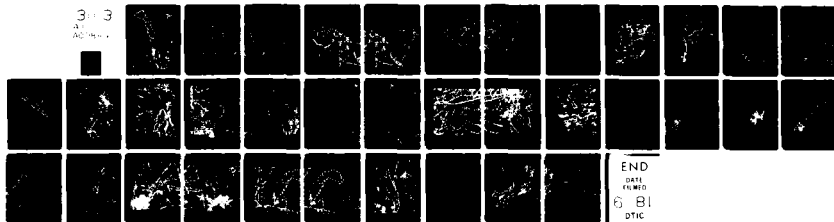
F/G 13/2

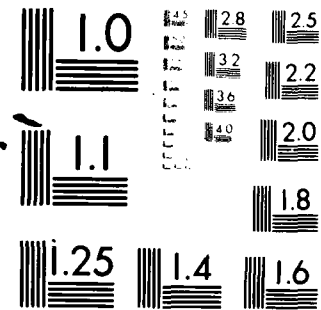
UNCLASSIFIED

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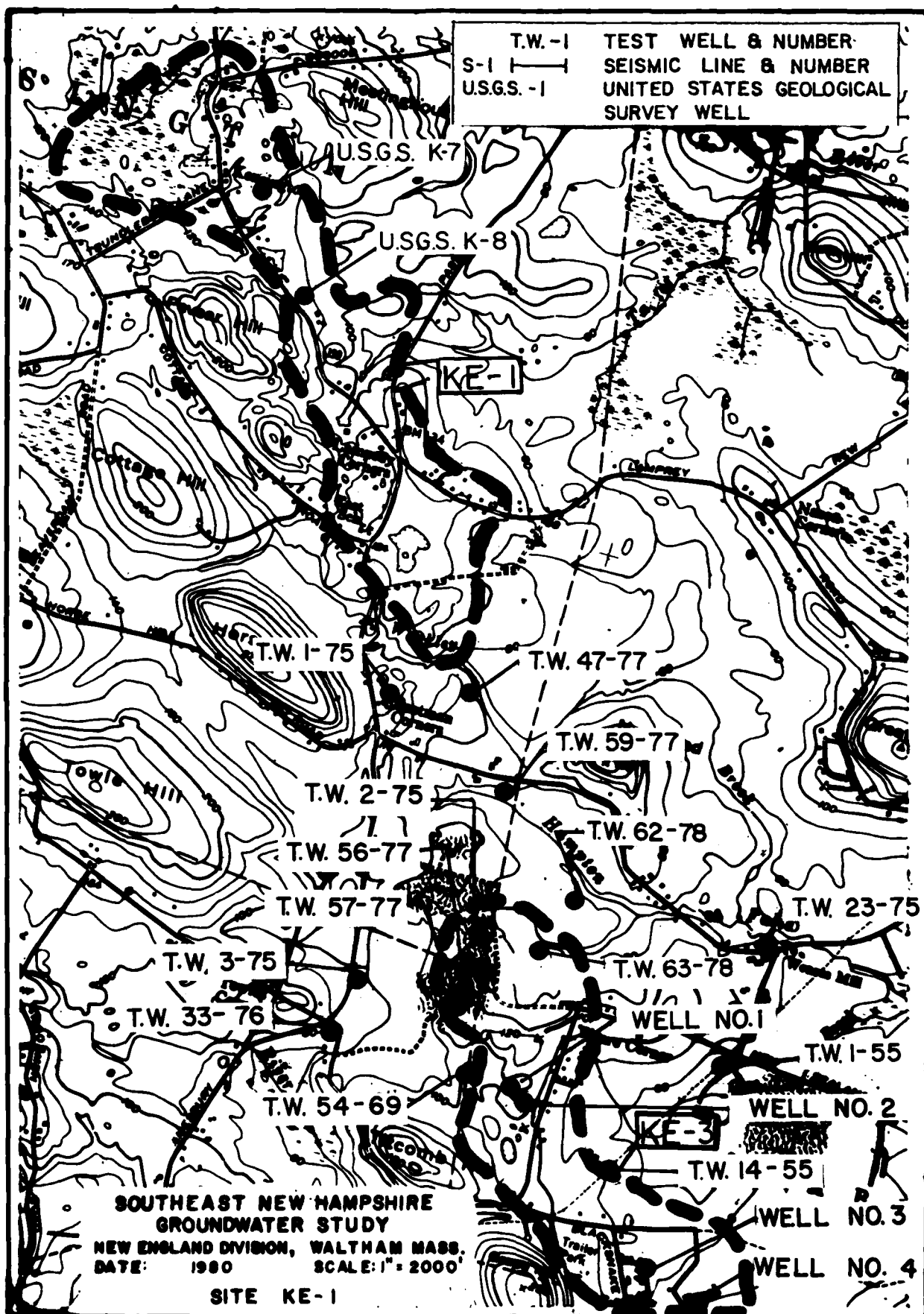
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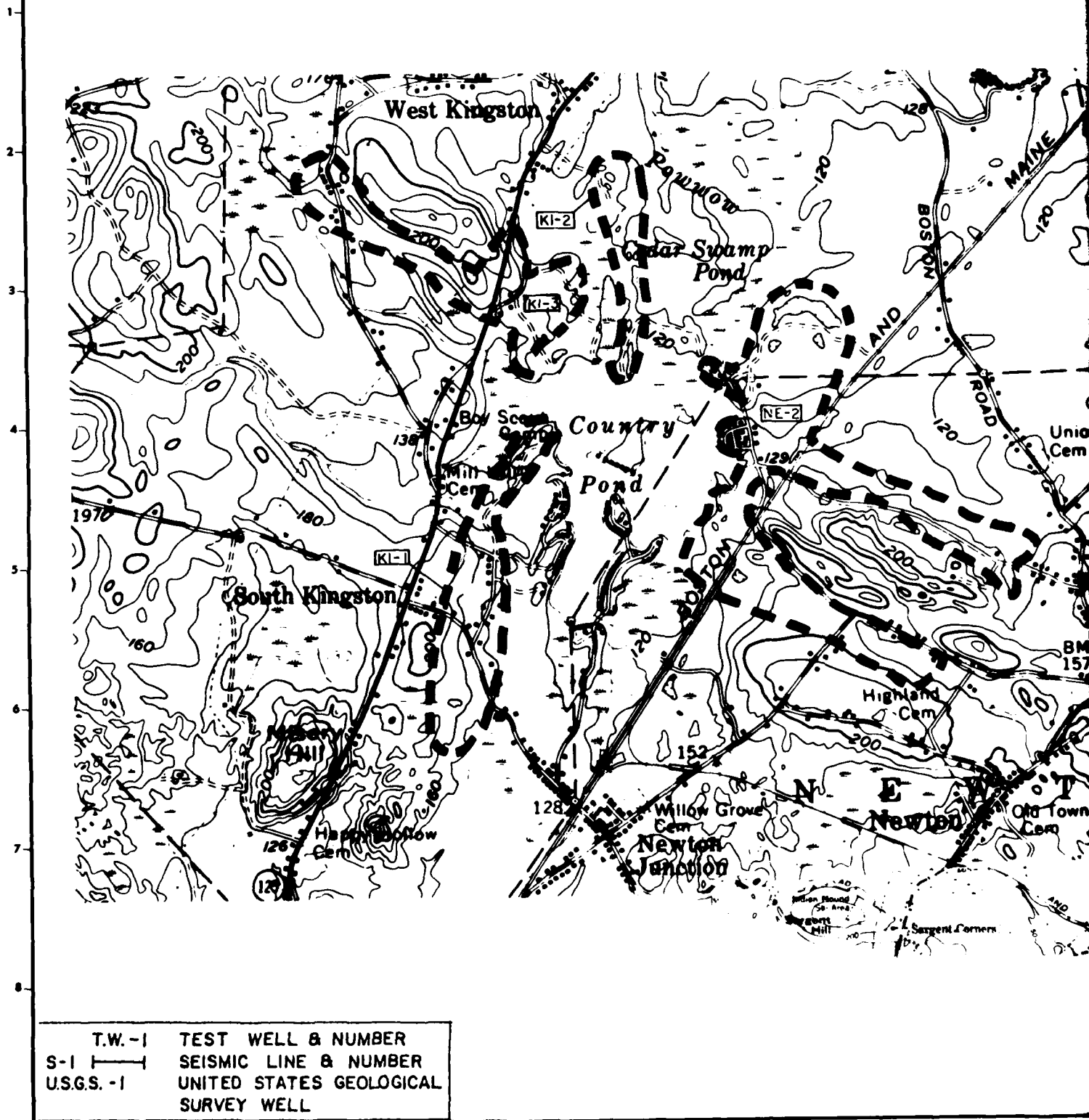
AD 13/2

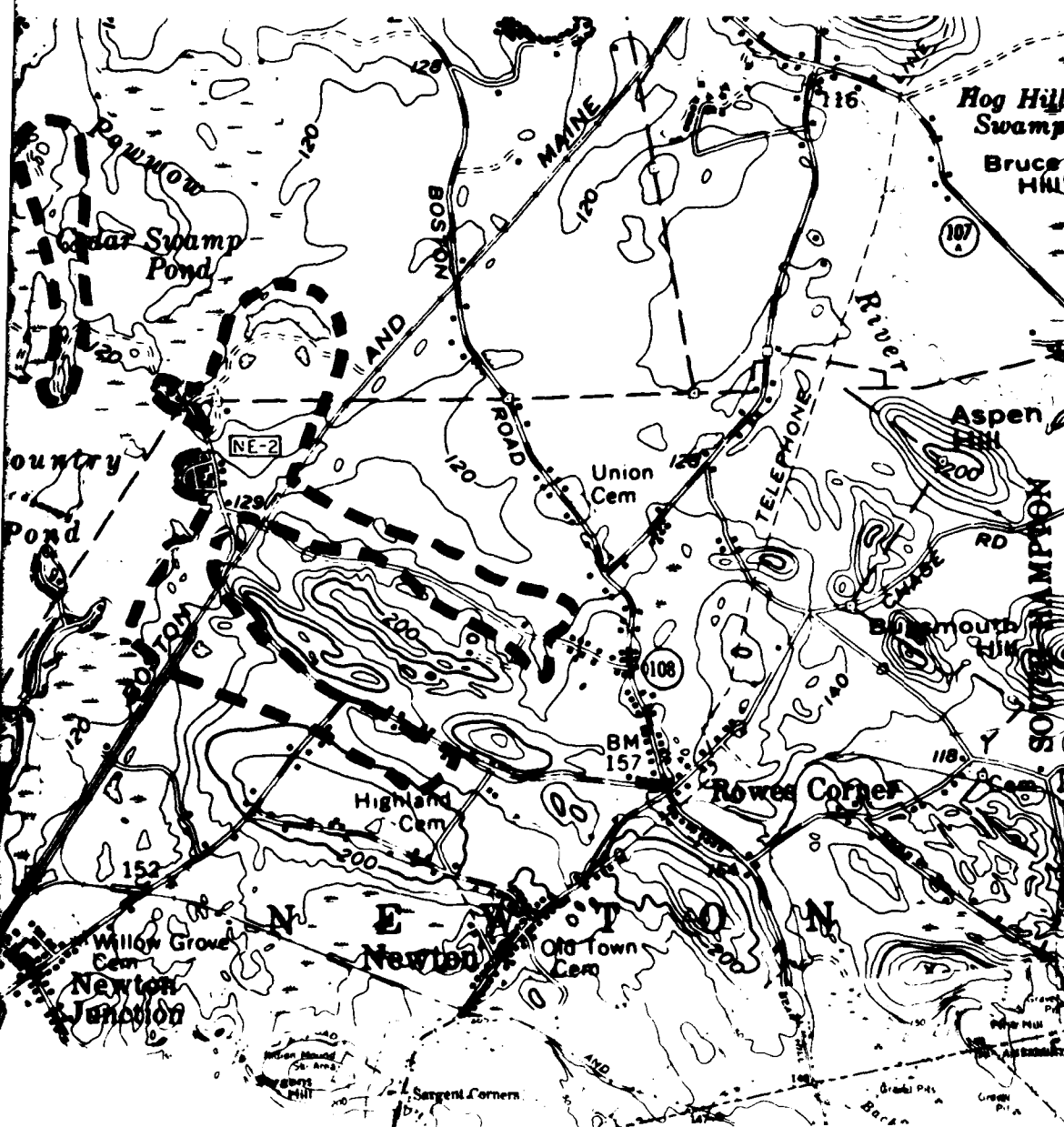




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



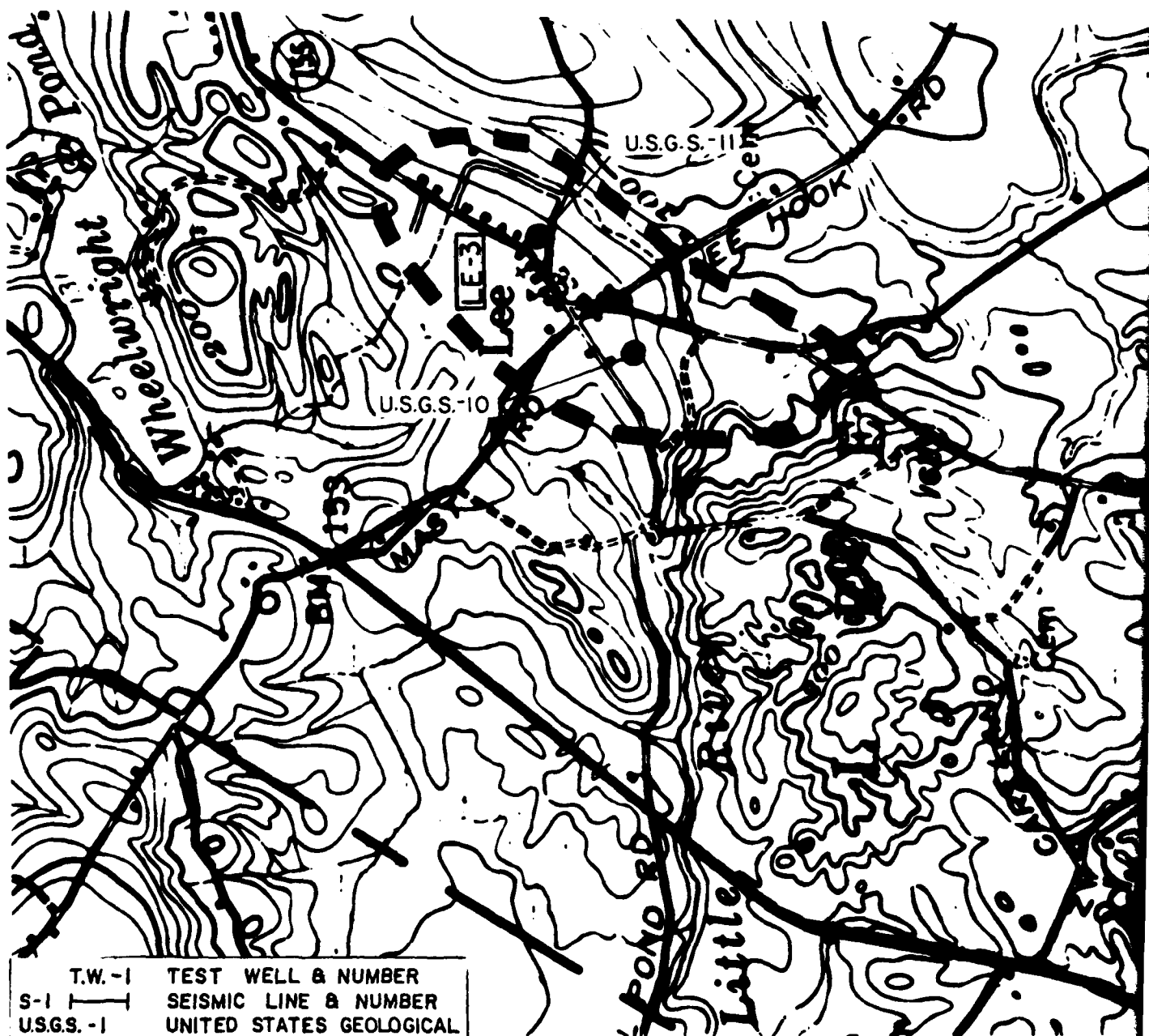


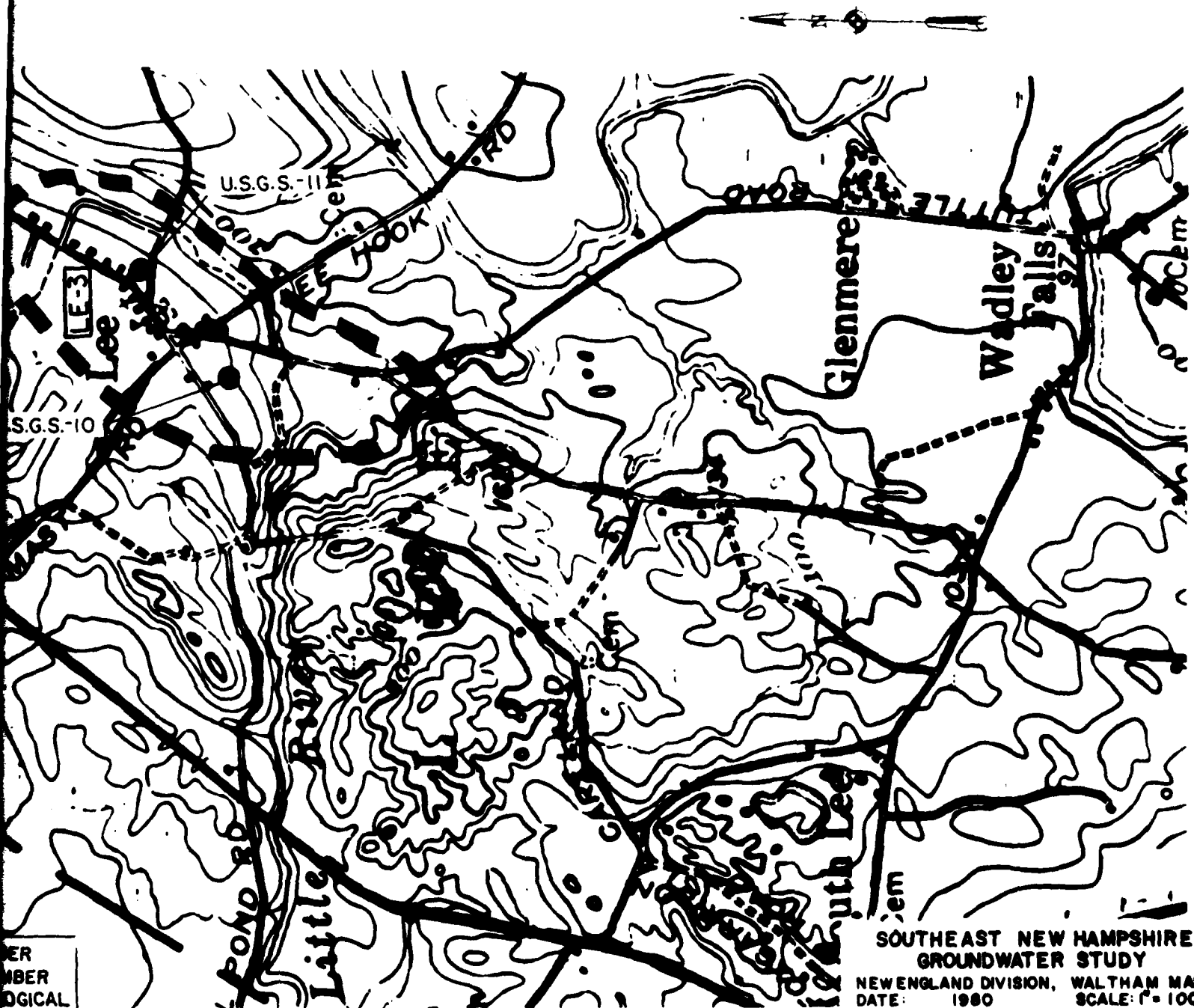


SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION - WALTHAM
DATE 1980 SCALE 1:50,000
SITE KI-1, KI-2, KI-3, NE

PLATE 1 KI-1, KI-2, KI-3

2





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OLOGICAL

SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS
DATE: 1980 SCALE: 1" = 100'
SITE LE-3

PLATE-I

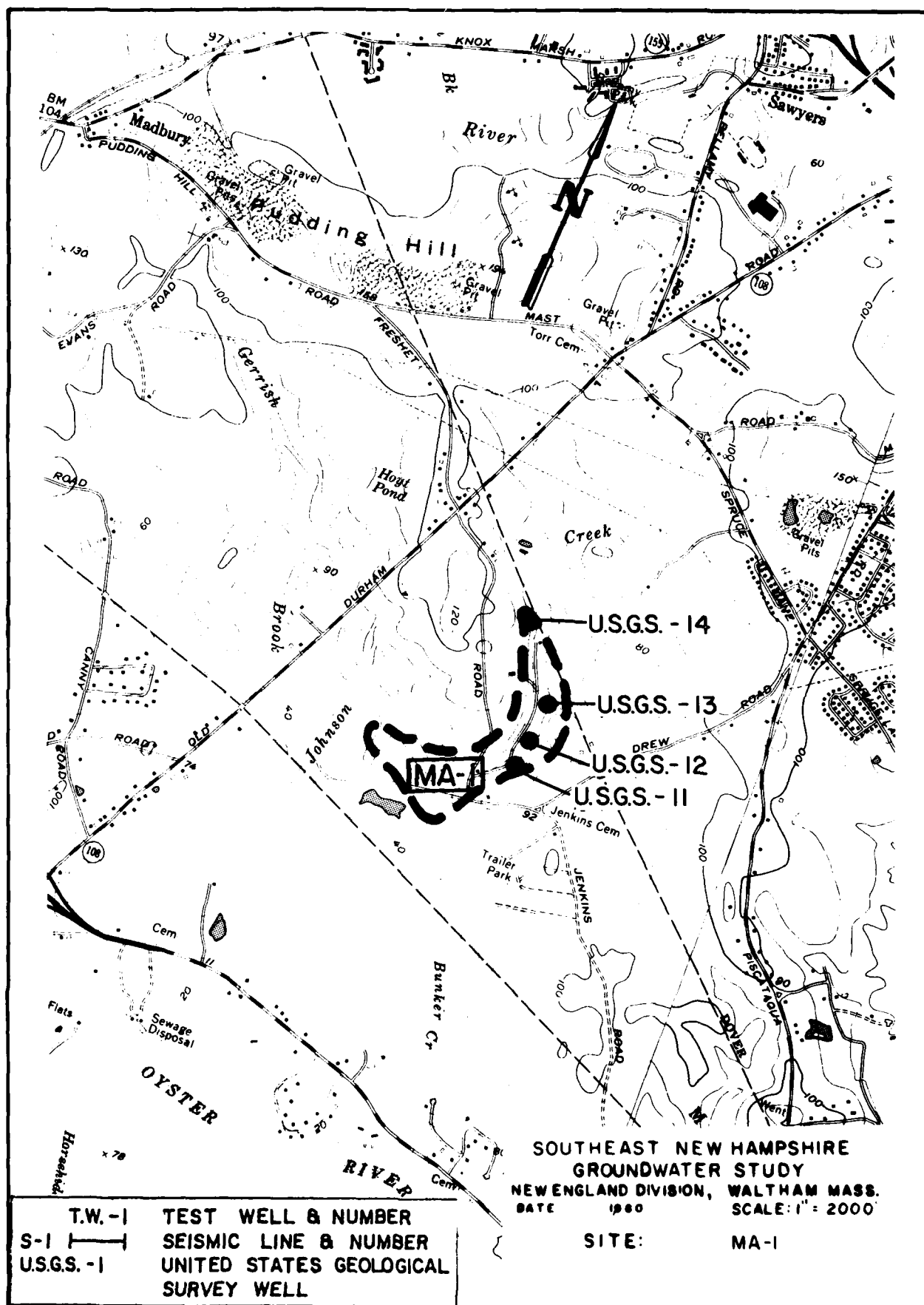
2



SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM
DATE 1980 SCALE 1" = 10
SITE LE-5, DU-1

2

PLATE 1 LE 5,



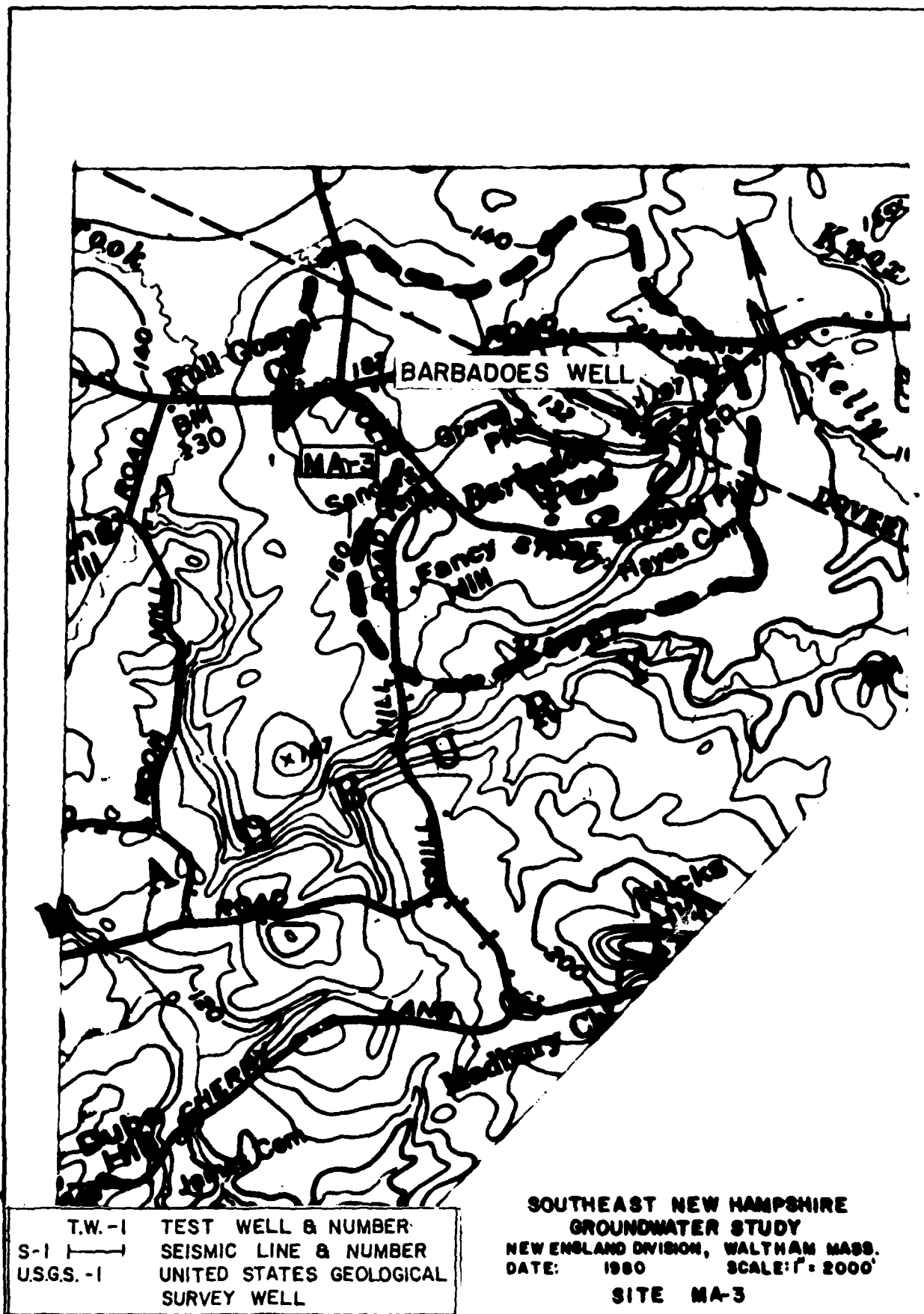


PLATE-1 MA-3

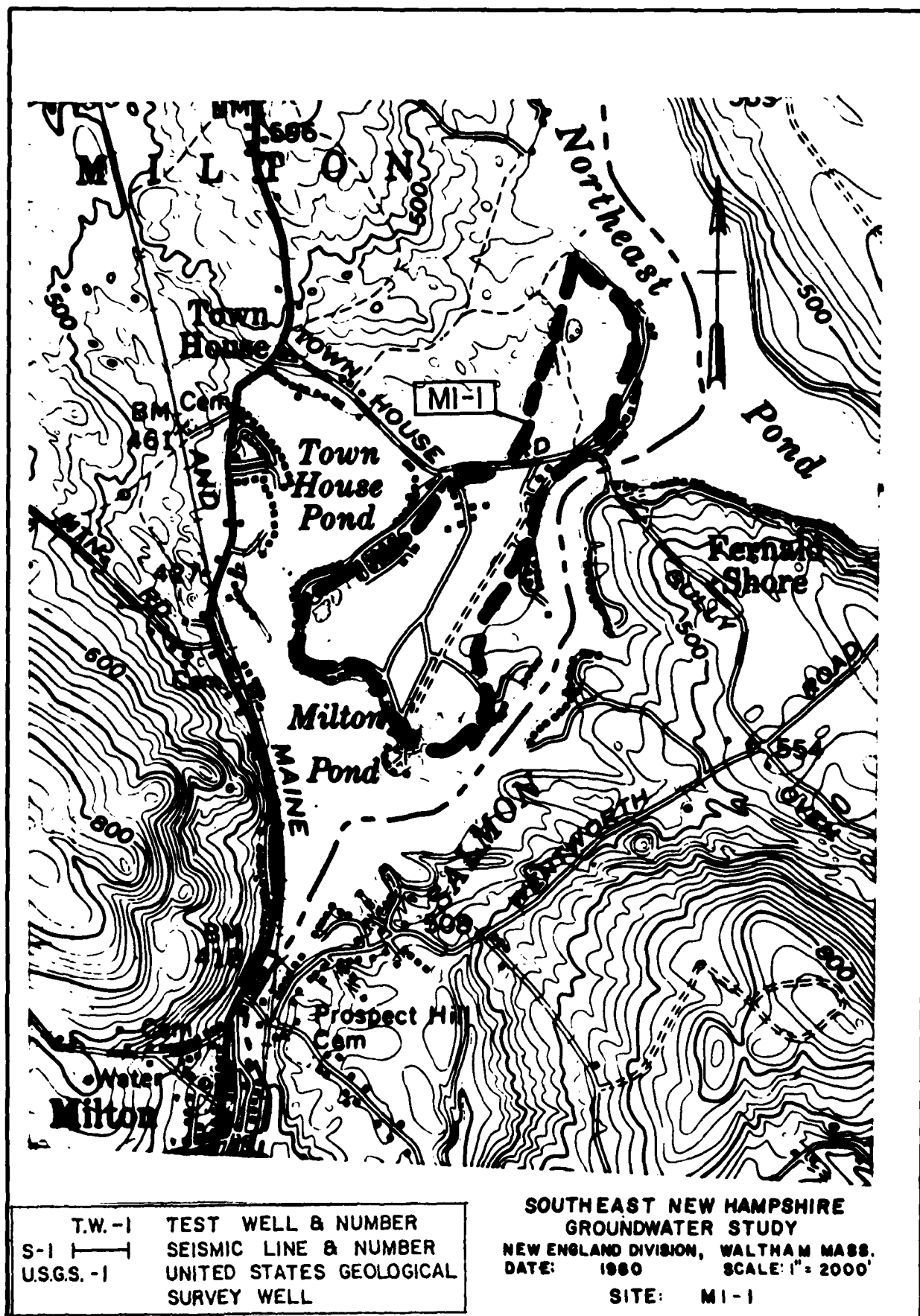
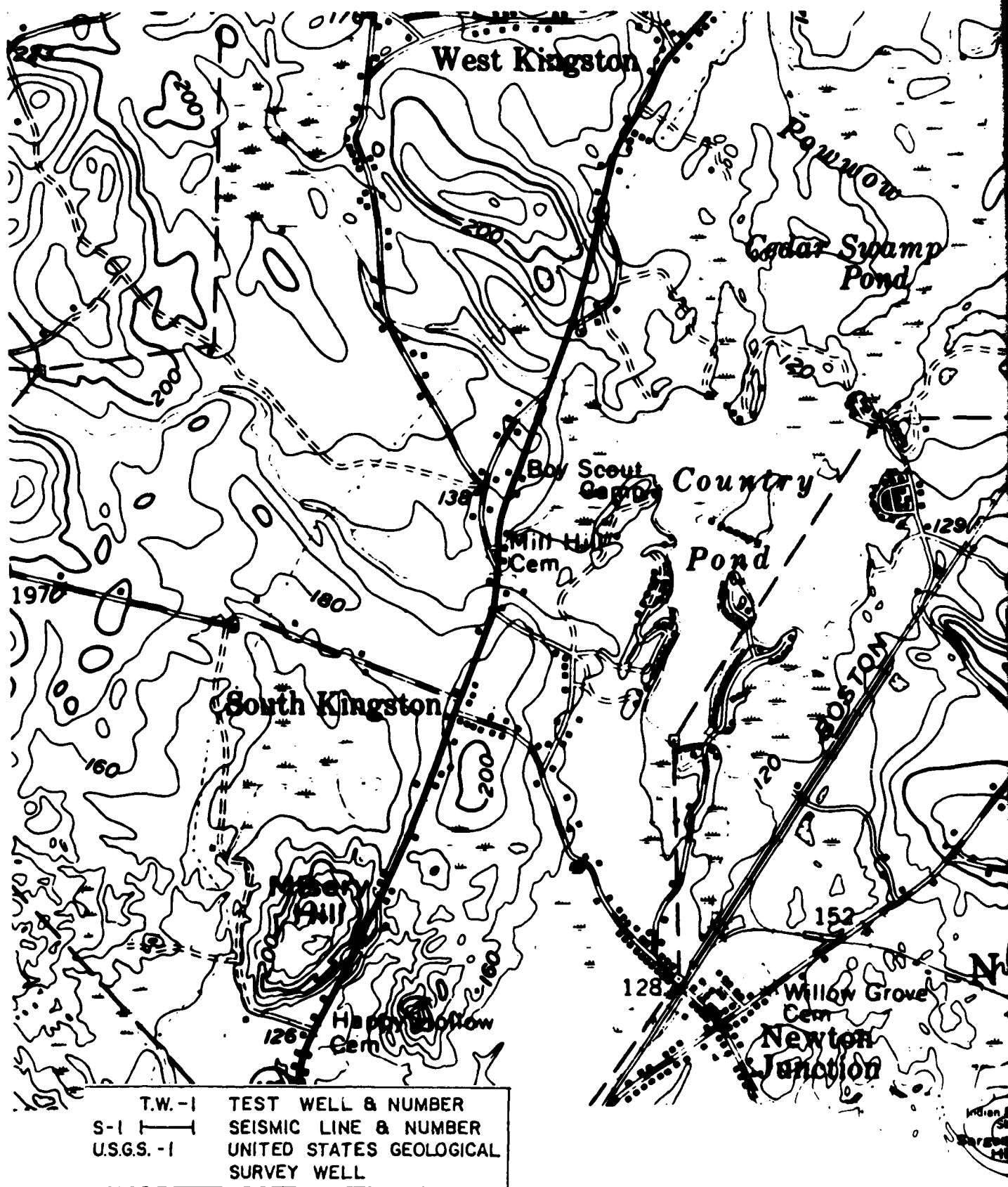
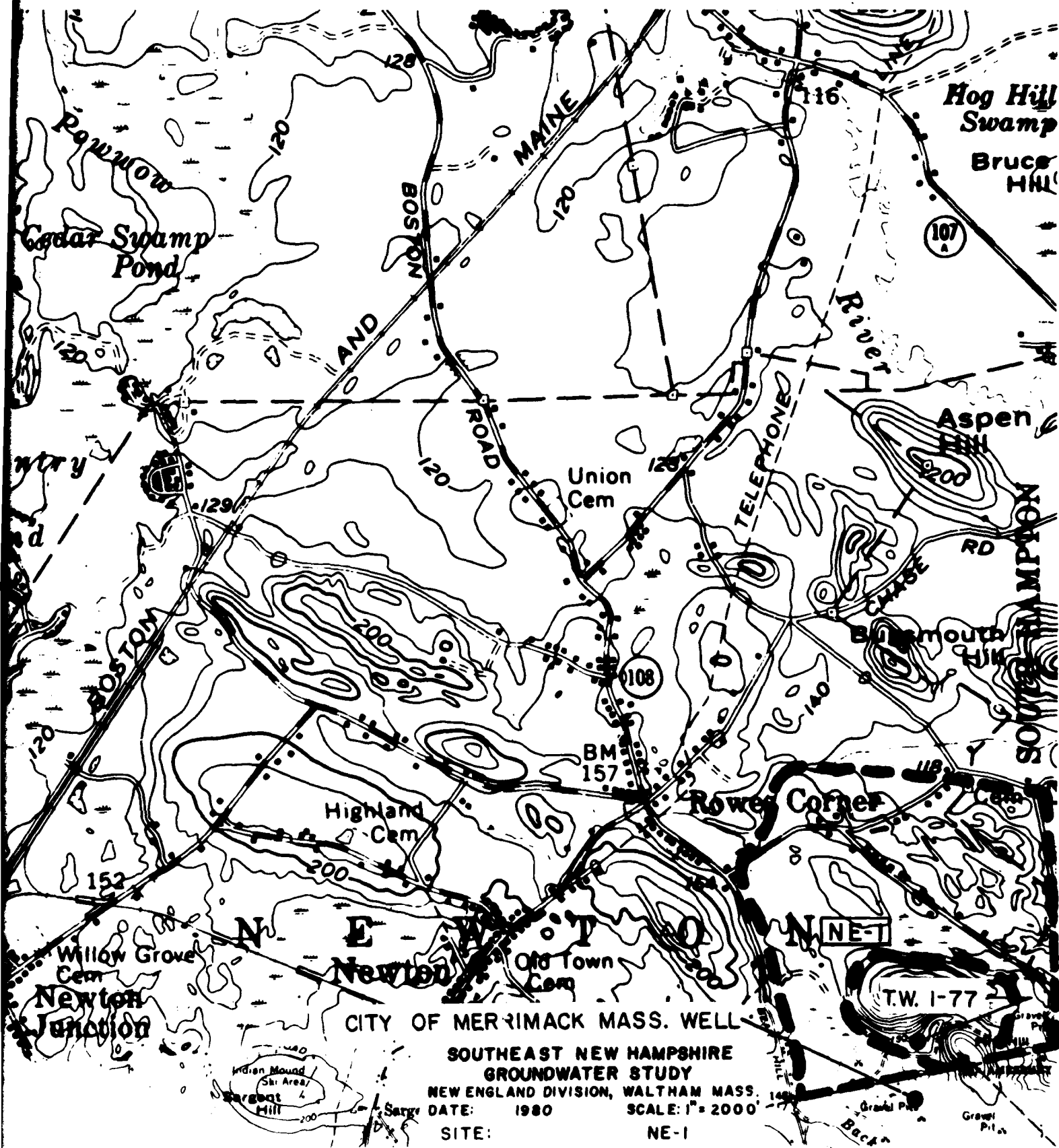
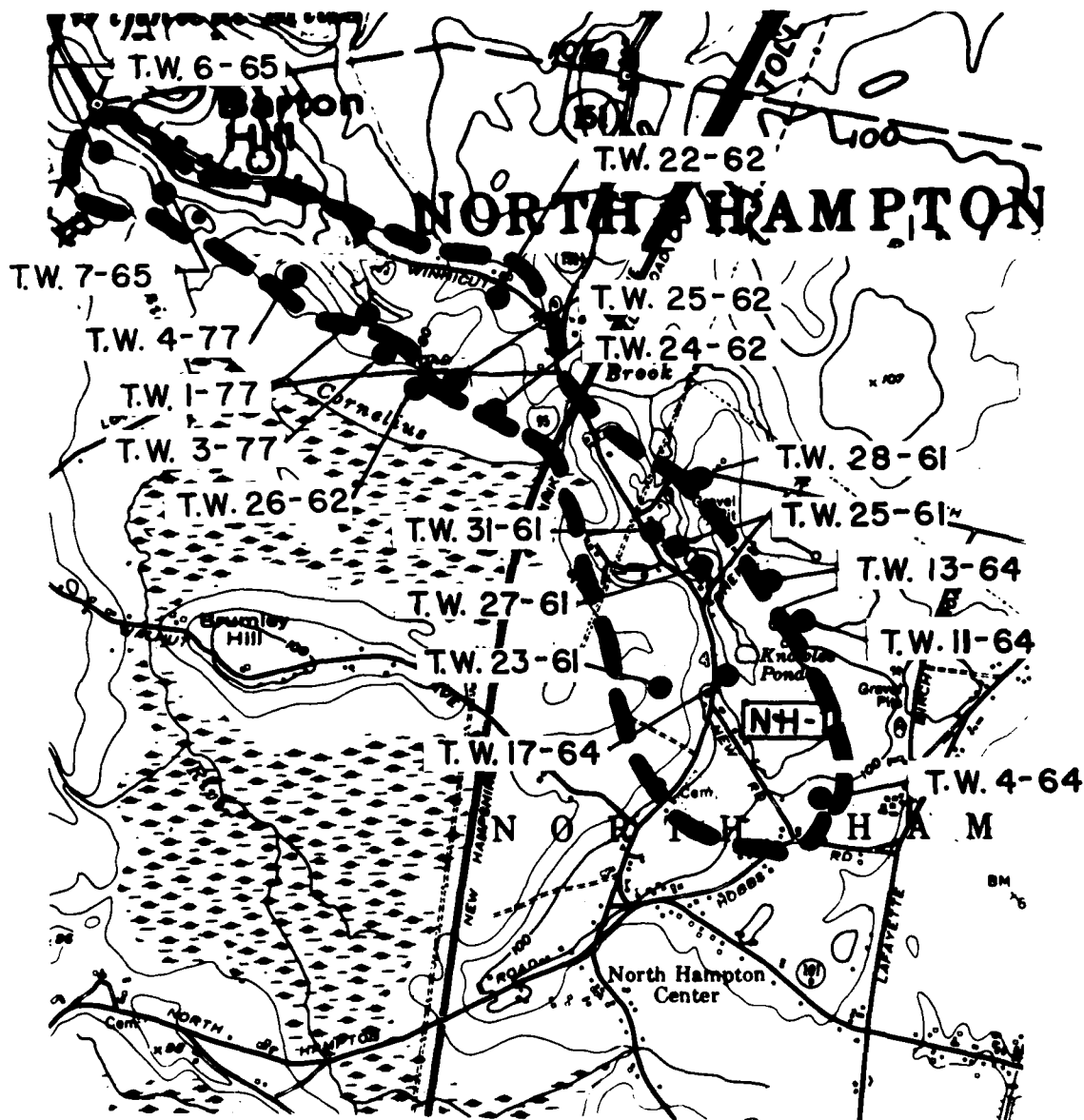


PLATE-1 MI-1



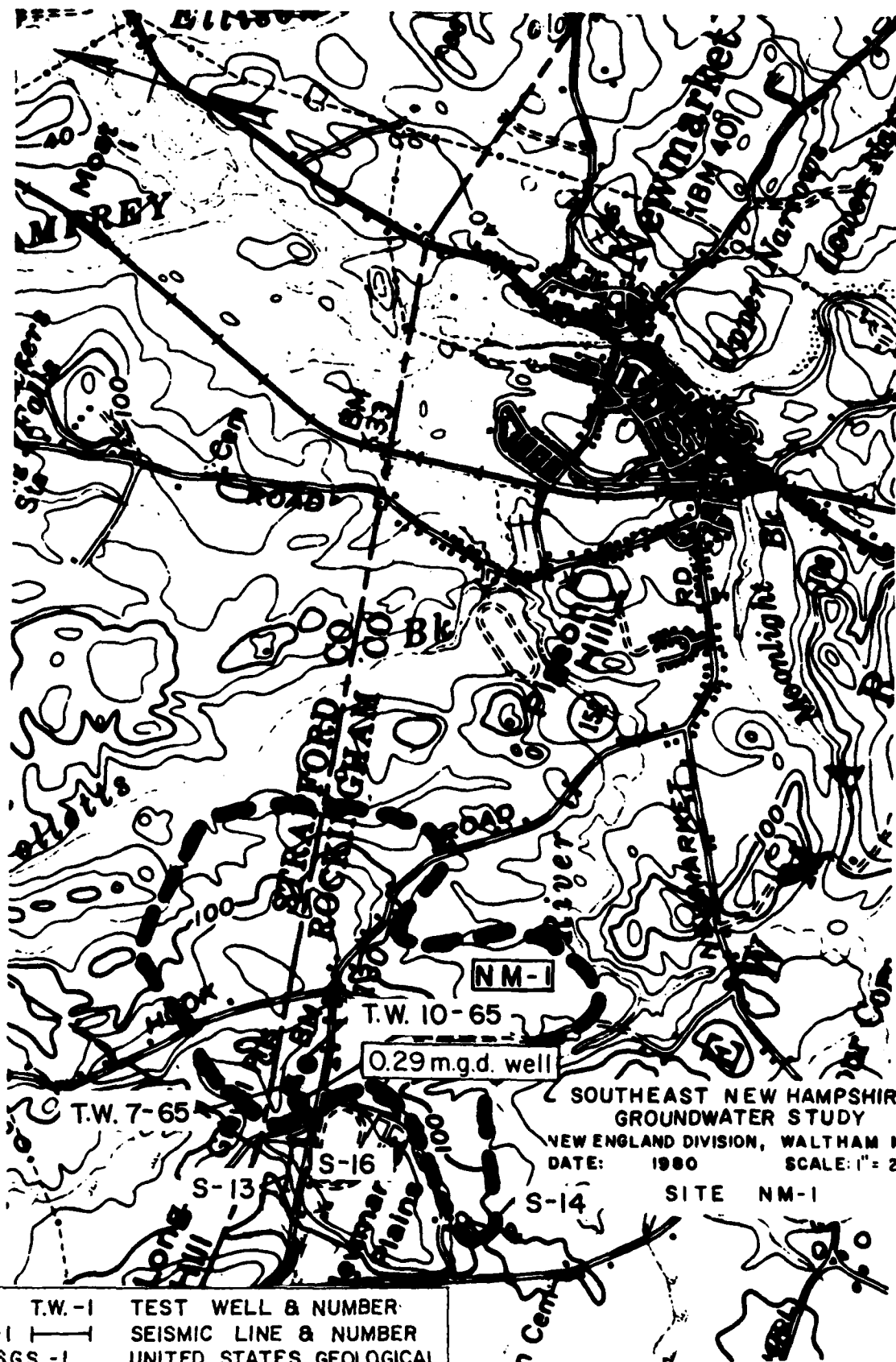




T.W. -1 TEST WELL & NUMBER
 S-1 SEISMIC LINE & NUMBER
 U.S.G.S. -1 UNITED STATES GEOLOGICAL SURVEY WELL

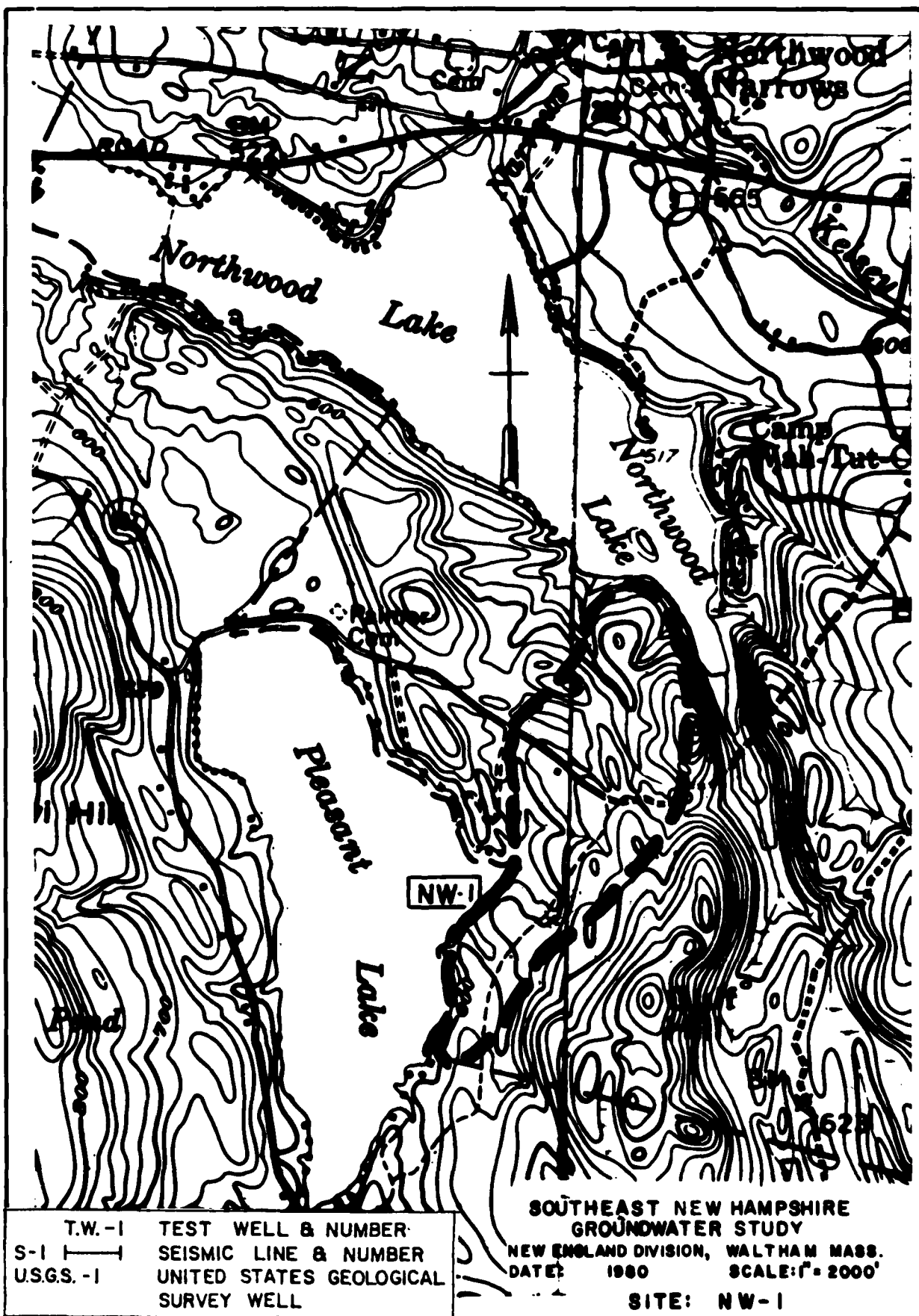
SOUTHEAST NEW HAMPSHIRE
 GROUNDWATER STUDY
 NEW ENGLAND DIVISION, WALTHAM MASS.
 DATE: 1980 SCALE: 1" = 2000'
 SITE NH-1

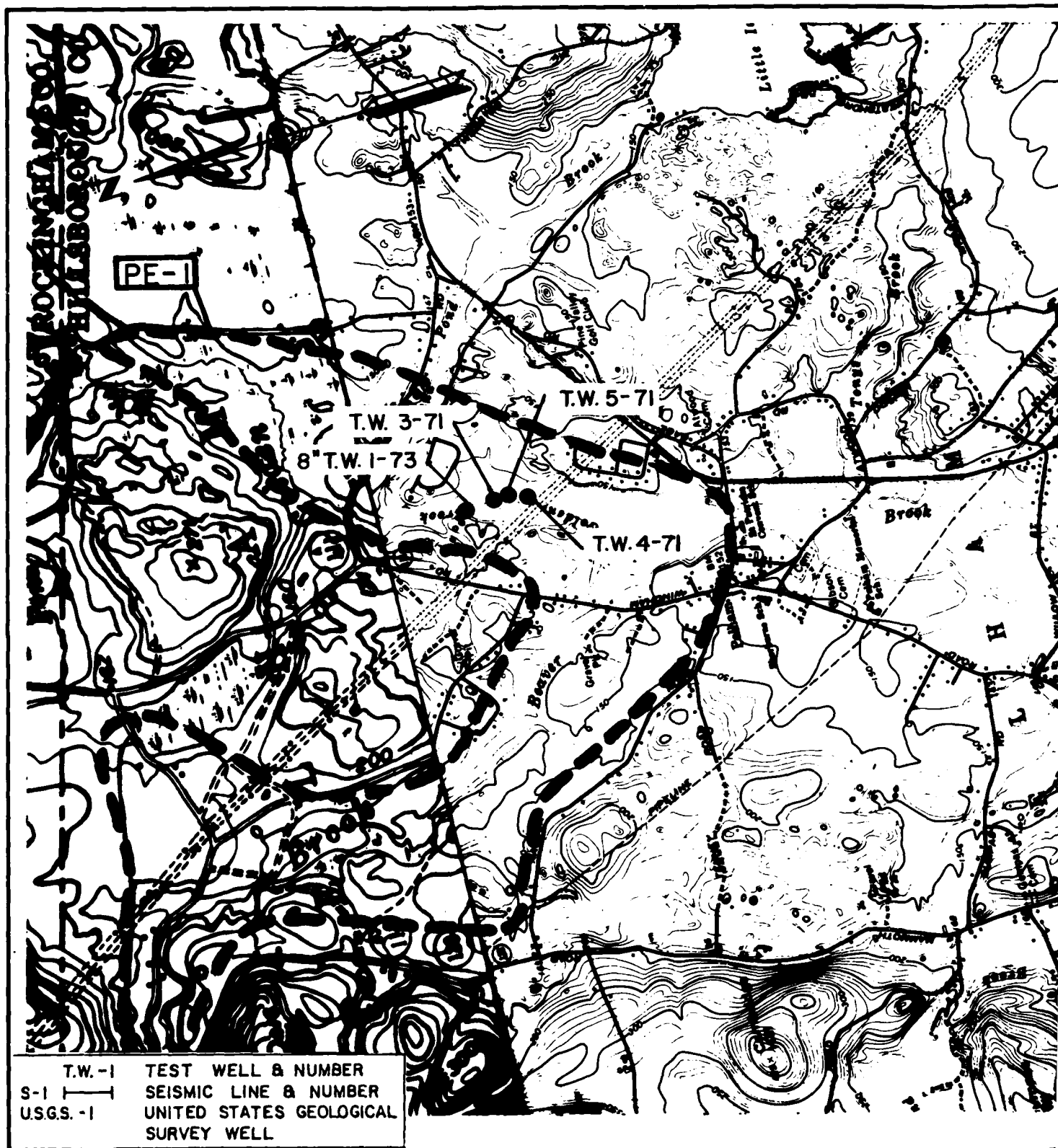
PLATE -1 NH-1

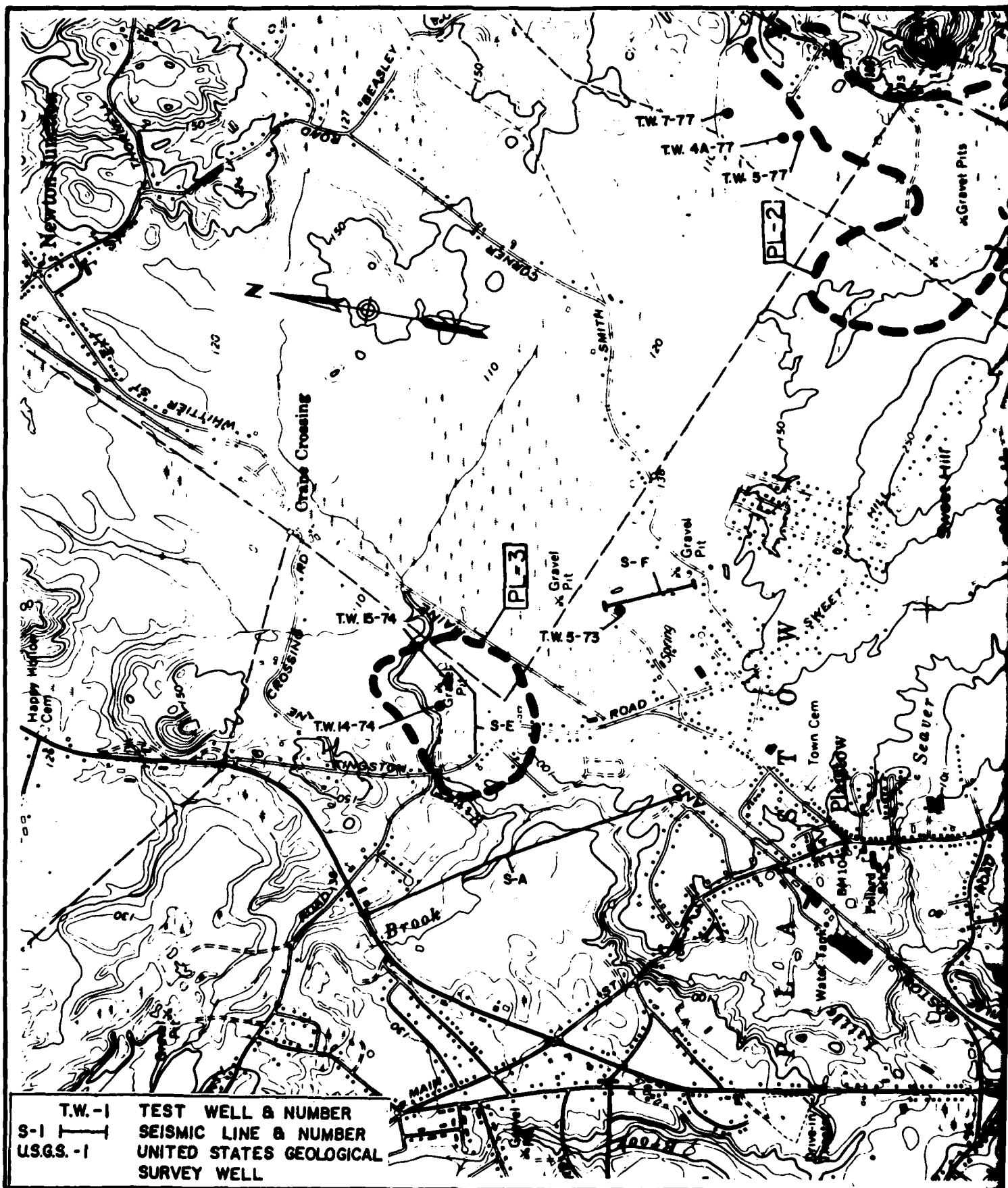


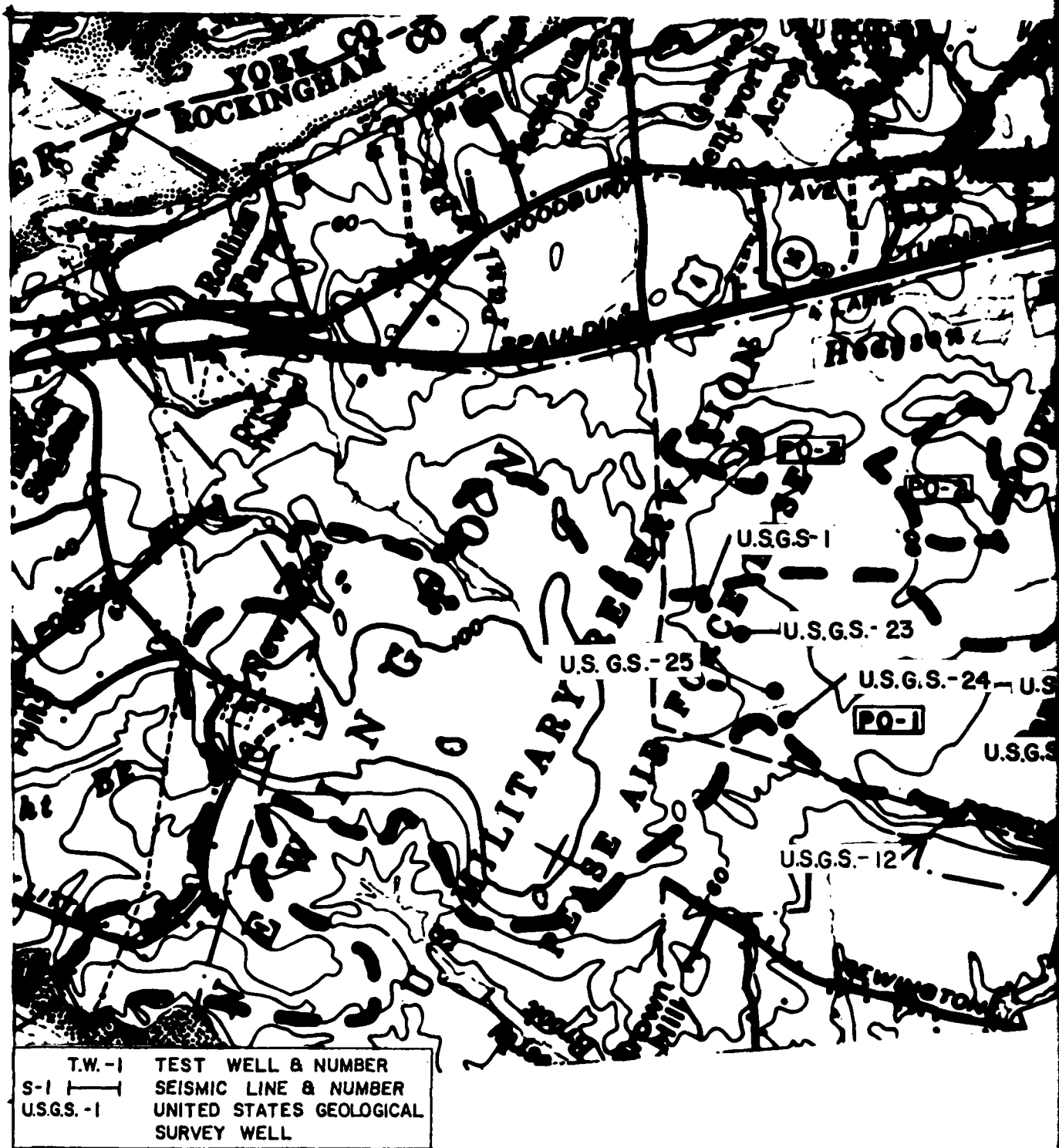
T.W. -1	TEST WELL & NUMBER
S-1	SEISMIC LINE & NUMBER
U.S.G.S. -1	UNITED STATES GEOLOGICAL SURVEY WELL

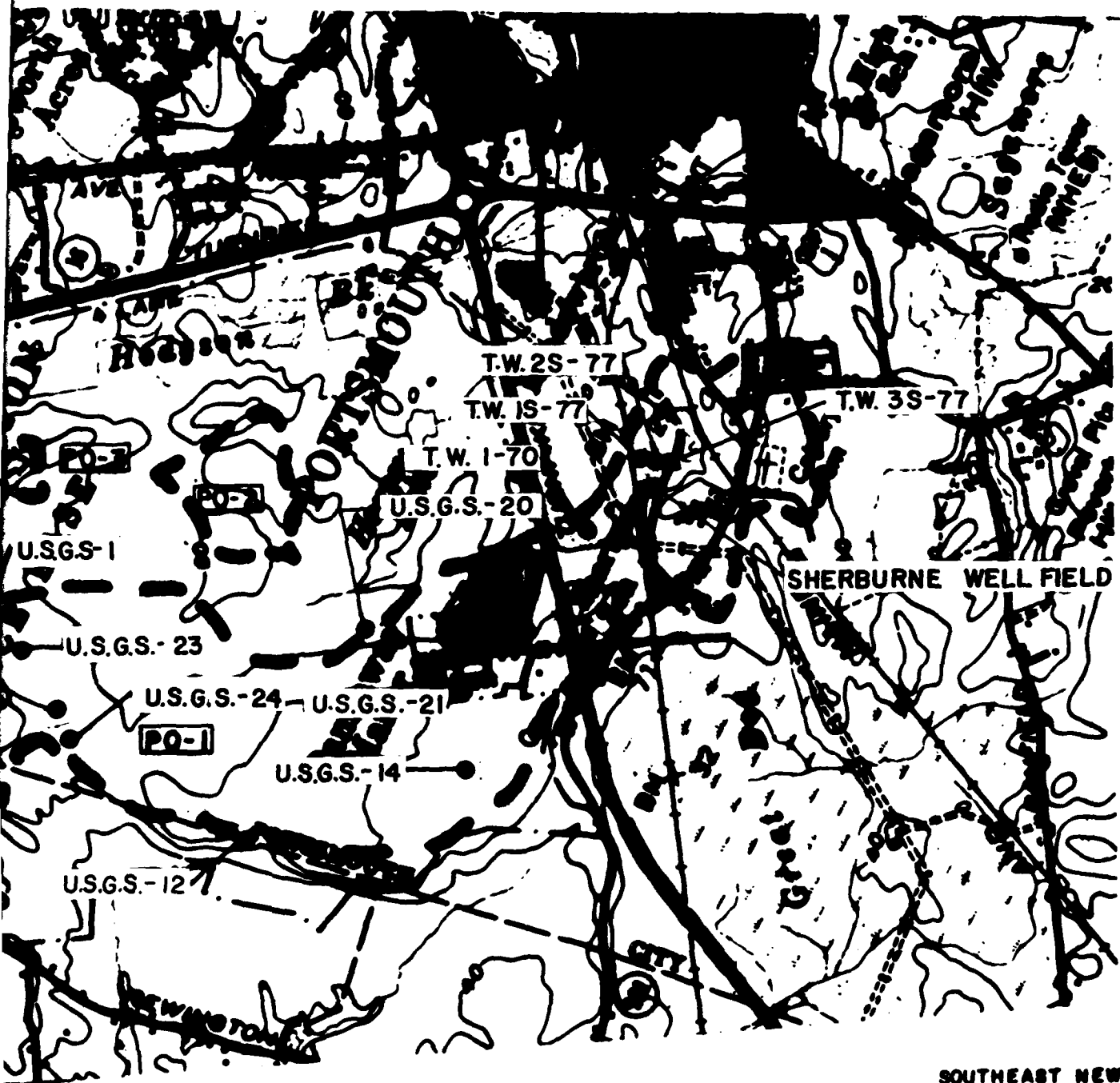
PLATE-1 NM-1











SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS.
DATE: 1990 SCALE: 1" = 2000'
SITE: PO-1, PO-2, PO-3

PLATE-1 PO-1, PO-2, PO-3

2



T.W.-1	TEST WELL & NUMBER
S-1	SEISMIC LINE & NUMBER
U.S.G.S.-1	UNITED STATES GEOLOGICAL SURVEY WELL

SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS.
DATE: 1980 SCALE: 1" = 2000'
SITE: RA-1

PLATE-1 RA-1

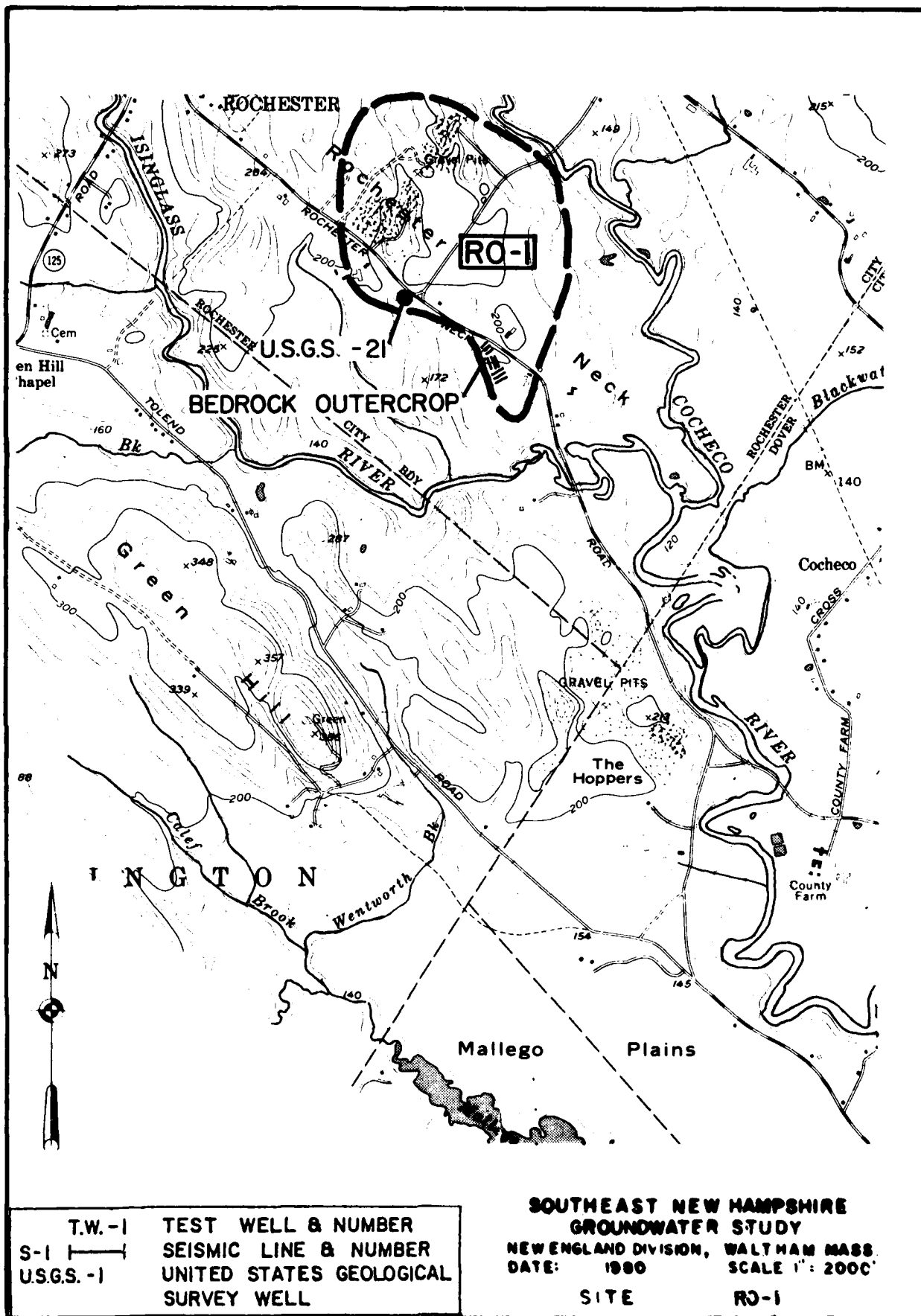
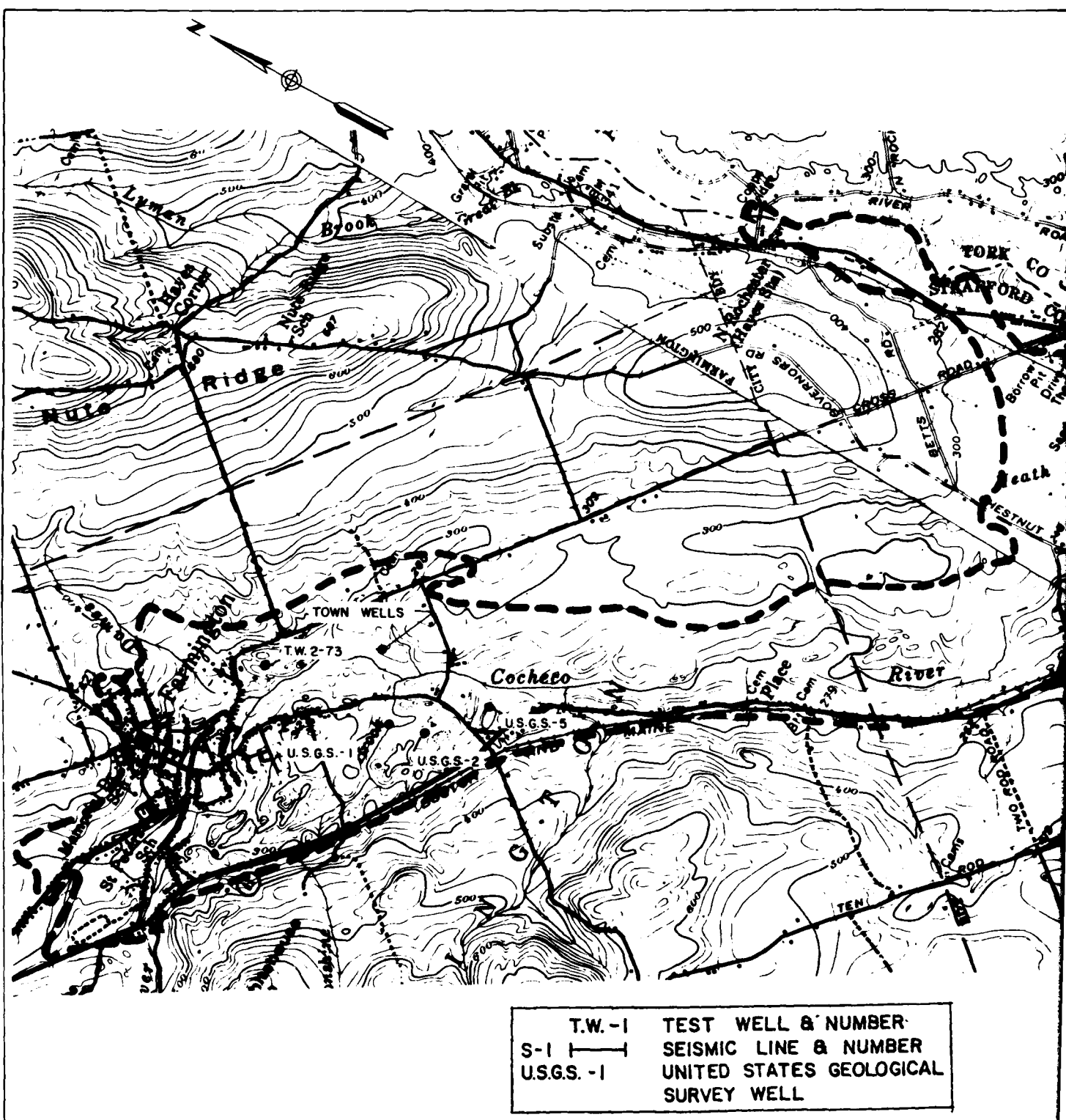


PLATE-1 RO-1



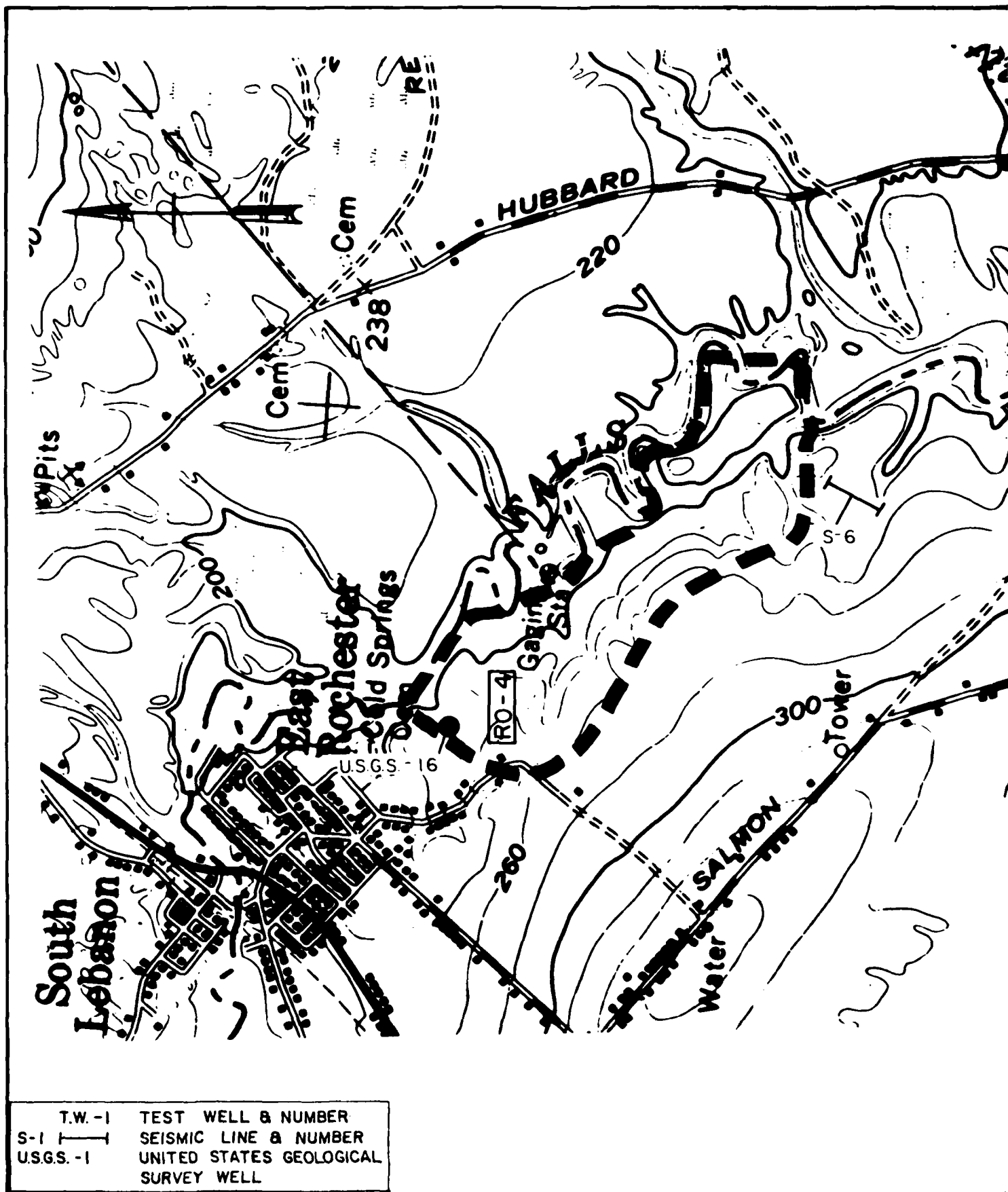


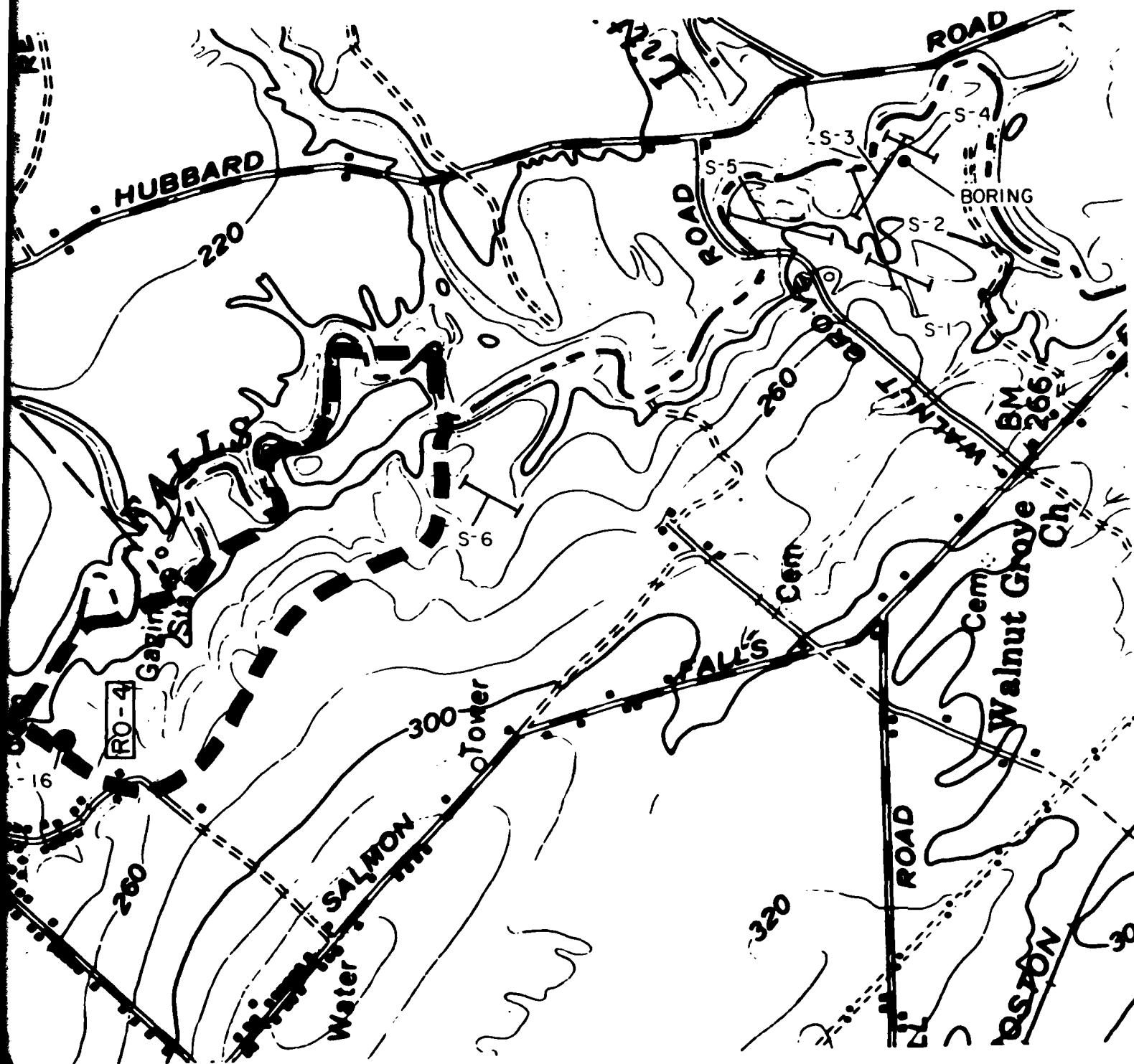
NUMBER
NUMBER
GEOLOGICAL

SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MA
DATE: 1980 SCALE: 1" = 10'
SITE: RO-2

PLATE-I

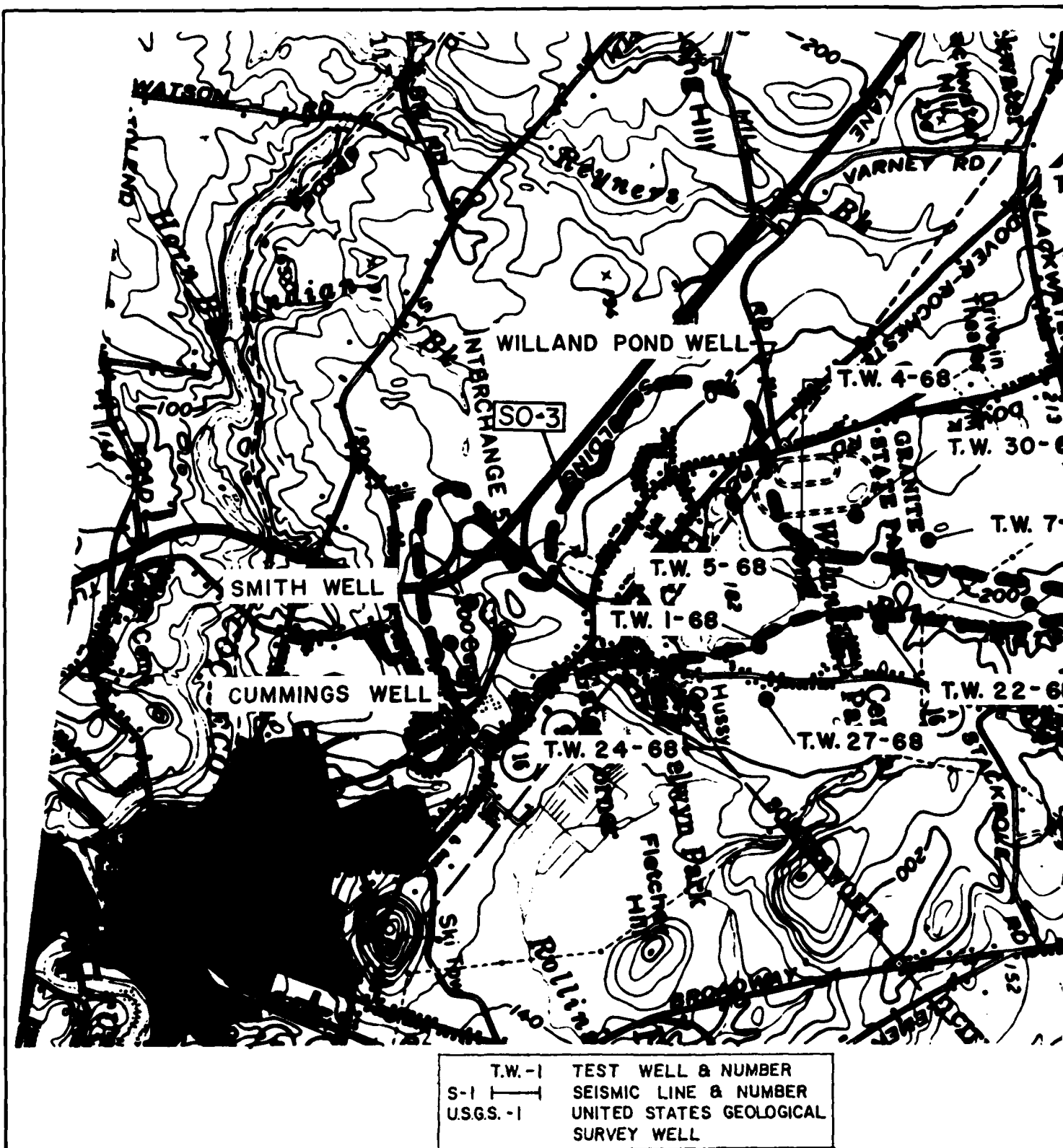
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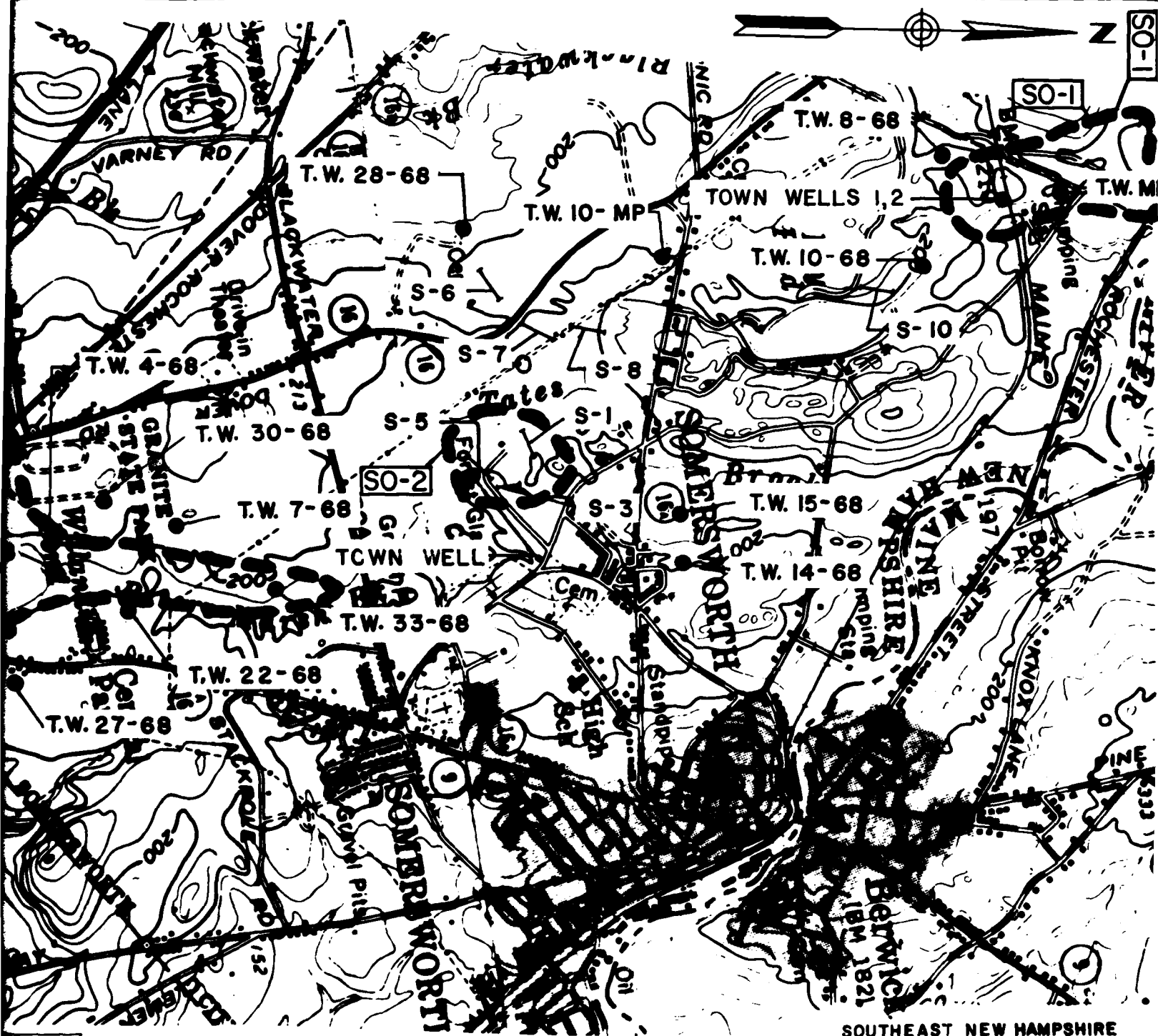




SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS.
DATE: 1980 SCALE: 1" = 1000'
SITE: RO-4

PLATE-1 R



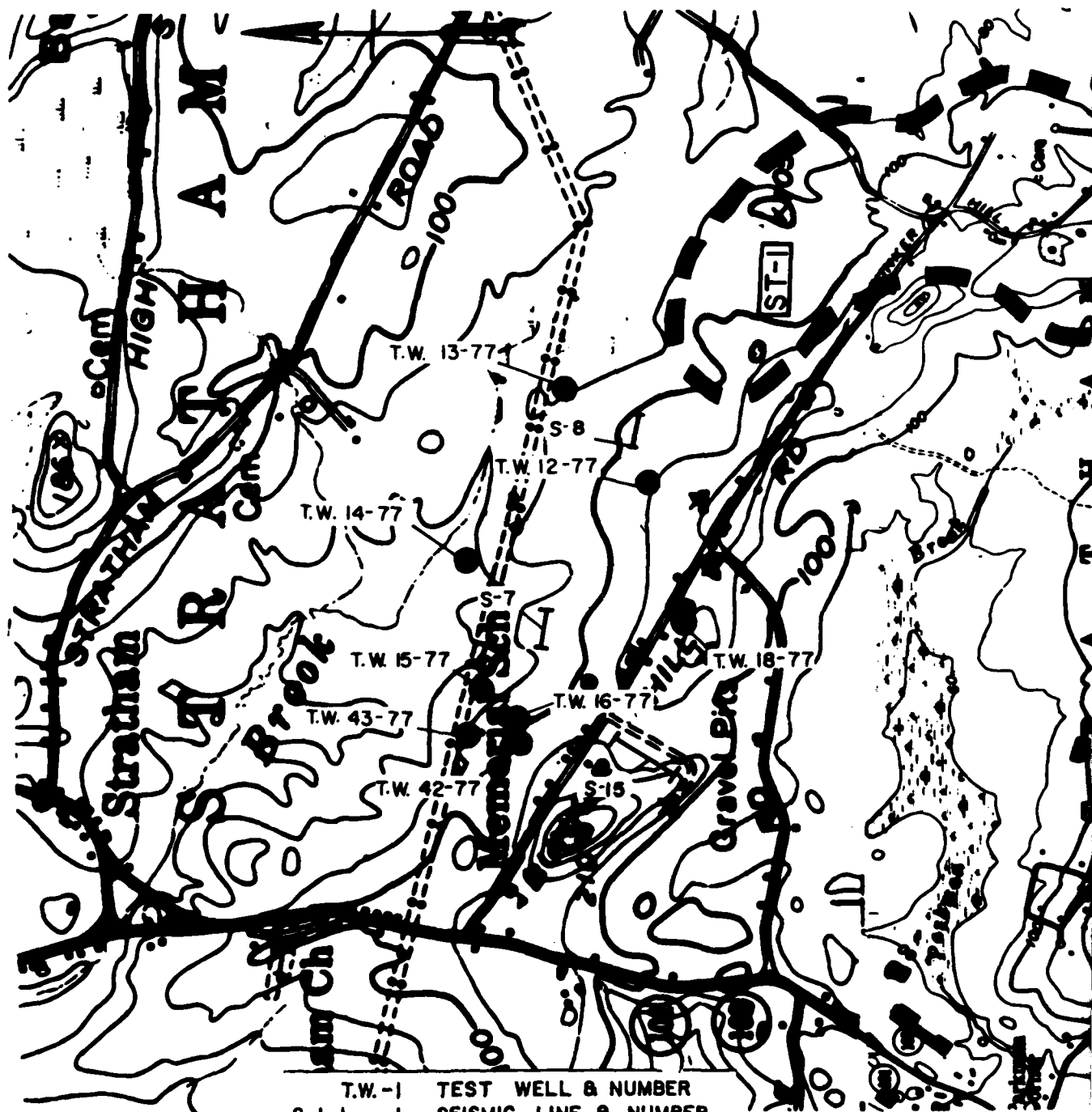


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LOGICAL

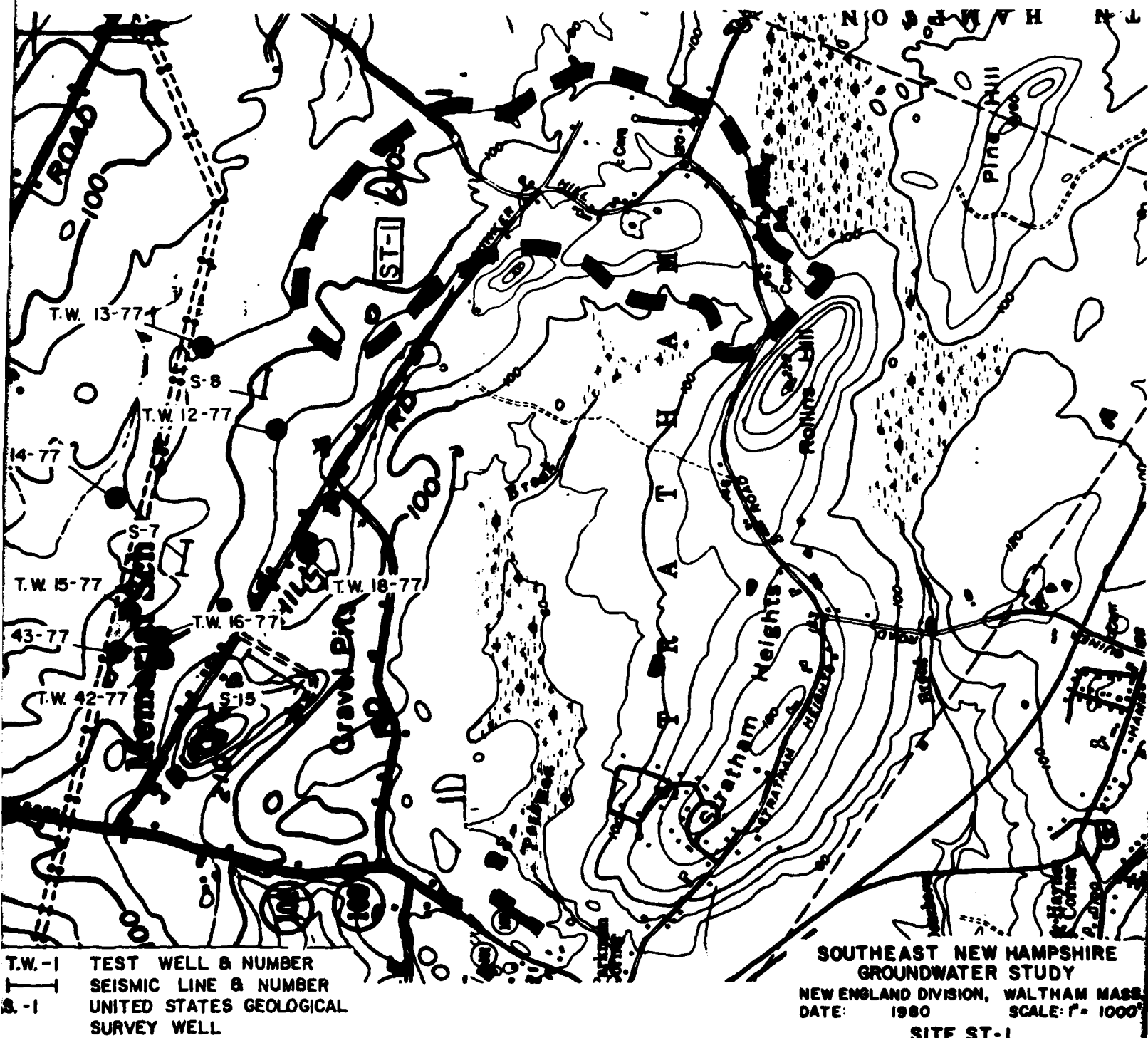
SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS.
DATE: 1980 SCALE: 1" = 2000'
SITE SO-1

PLATE-1 SO-1, SO-2, SO-3

2



T.W. - | TEST WELL & NUMBER
 S-1 | SEISMIC LINE & NUMBER
 U.S.G.S. - | UNITED STATES GEOLOGICAL
 SURVEY WELL



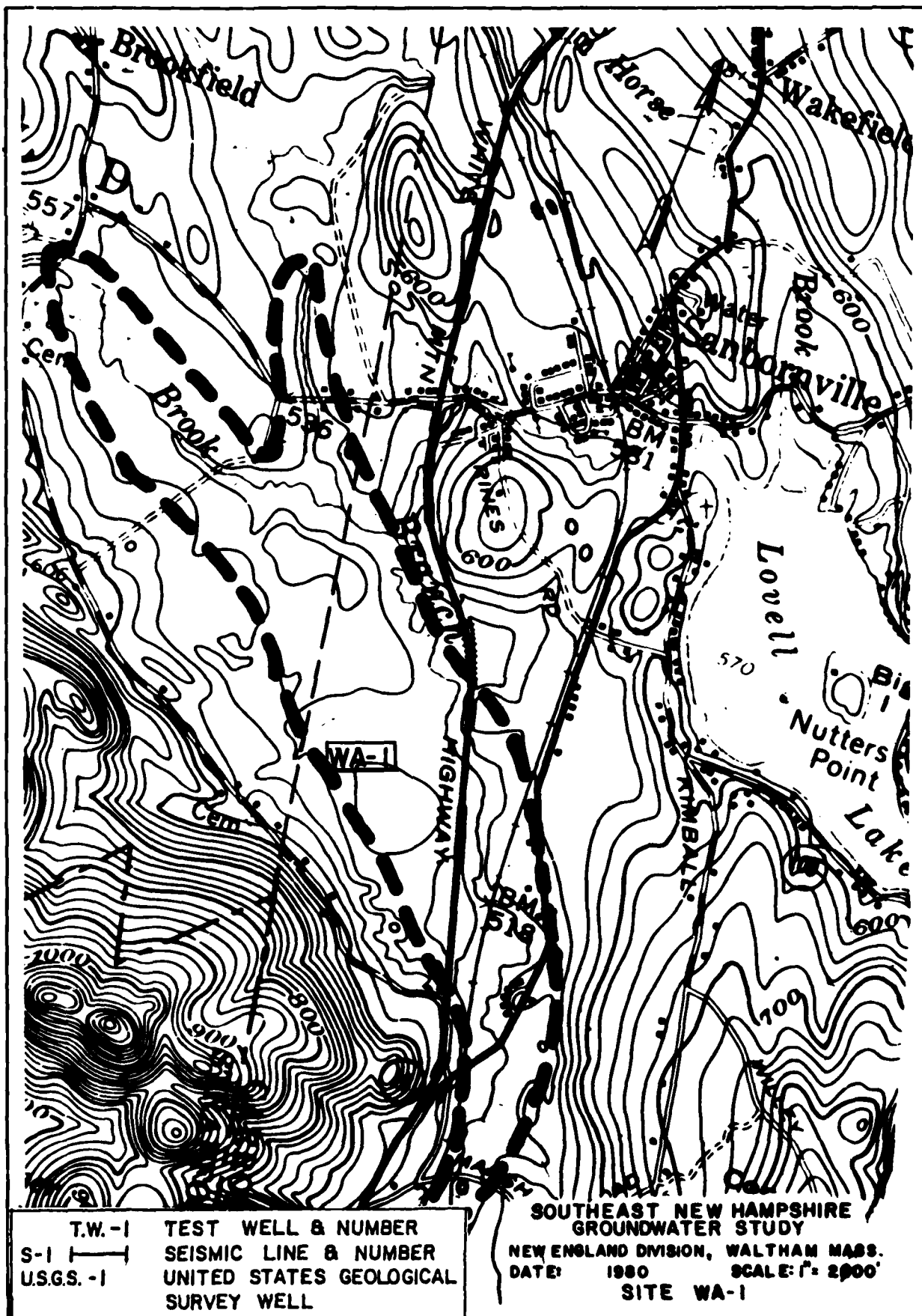


PLATE -1 WA-1

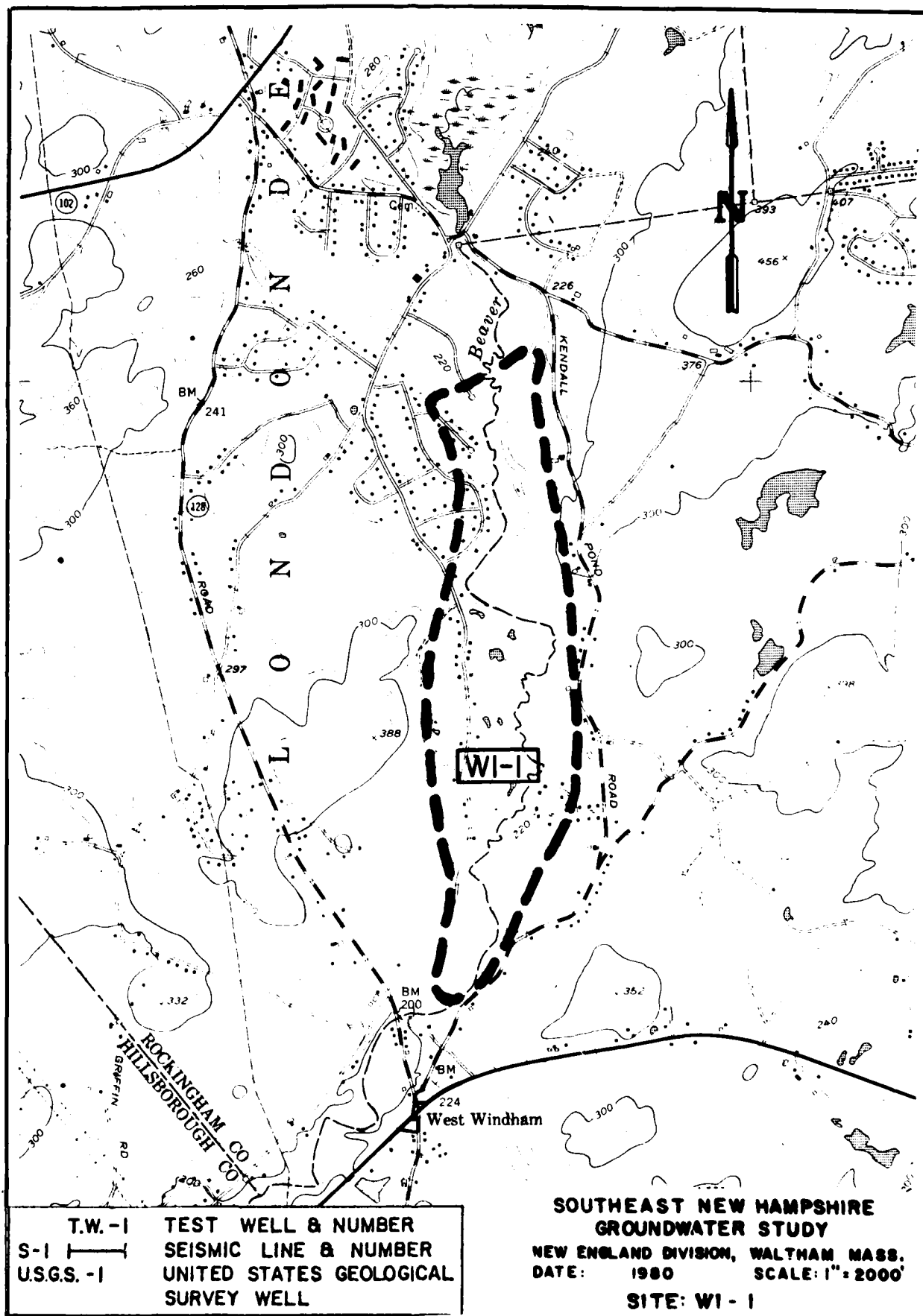
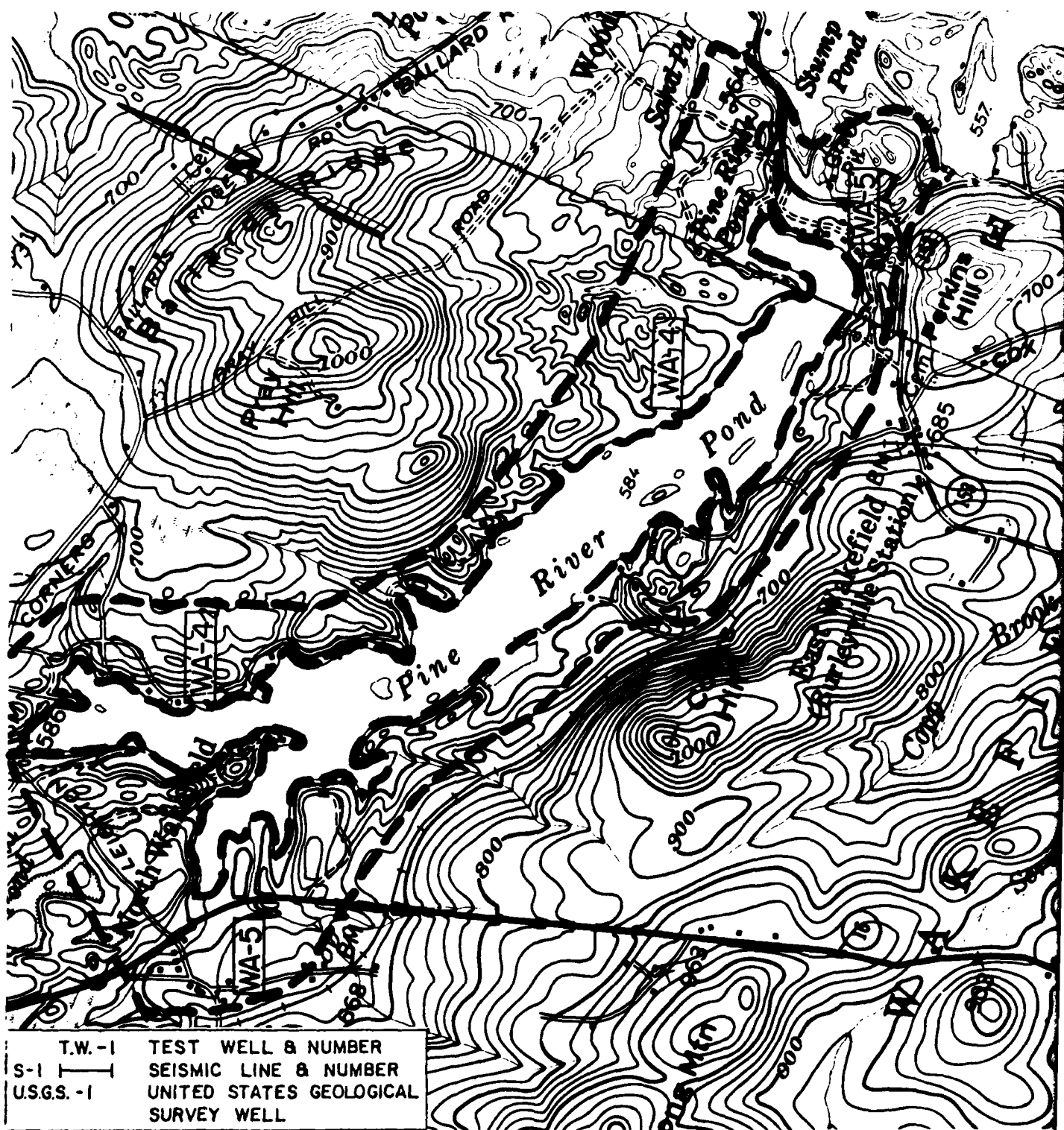
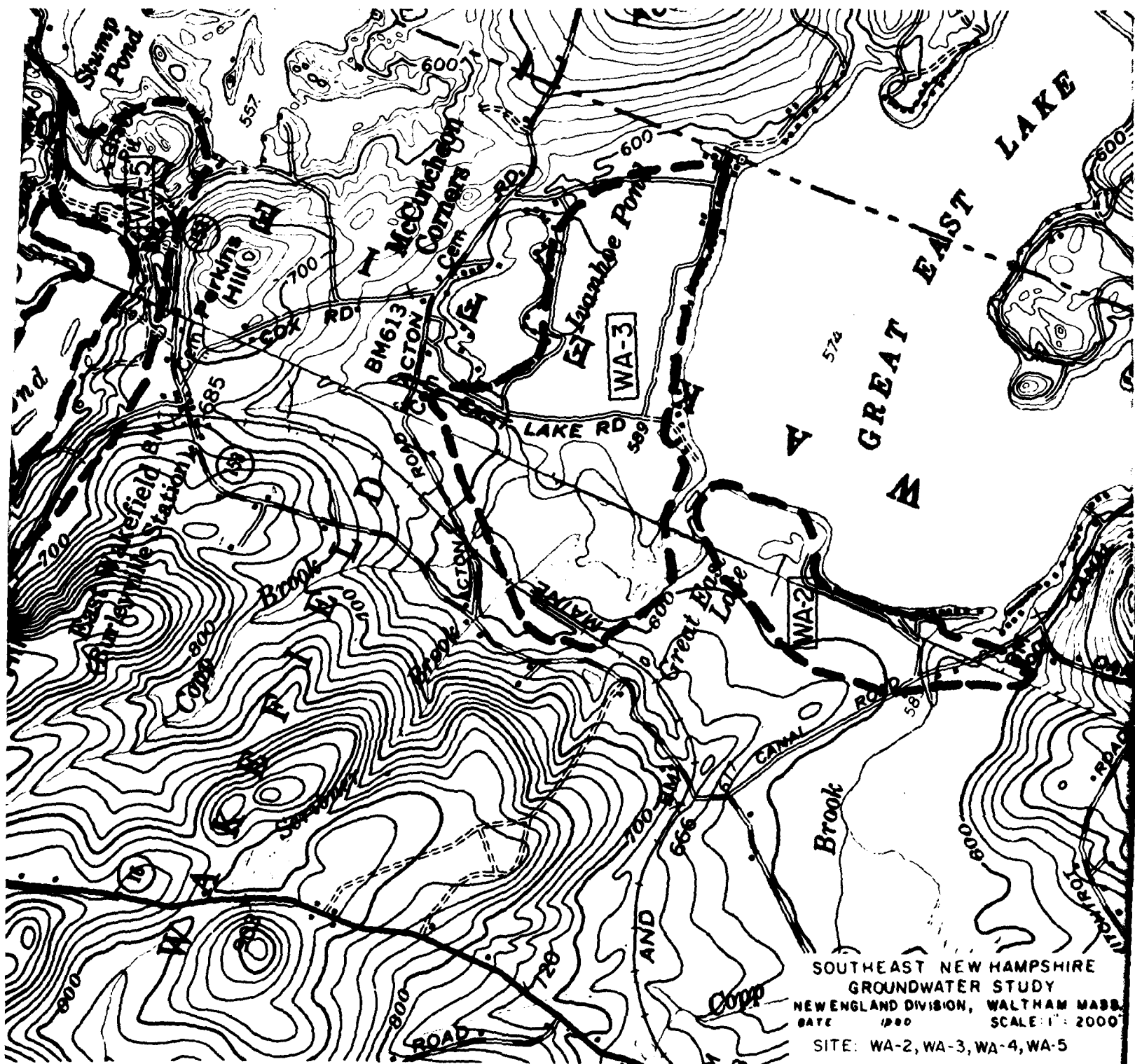


PLATE-1 WI-1



T.W. - I	TEST WELL & NUMBER
S-1 - I	SEISMIC LINE & NUMBER
U.S.G.S. - I	UNITED STATES GEOLOGICAL SURVEY WELL



SOUTHEAST NEW HAMPSHIRE
GROUNDWATER STUDY
NEW ENGLAND DIVISION, WALTHAM MASS.
DATE 1980 SCALE: 1" = 2000'
SITE: WA-2, WA-3, WA-4, WA-5

