Ground-Water Geology and Hydrology of the Maynard Area Massachusetts

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1539-E

Prepared in cooperation with Corps of Engineers, U.S. Army

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By N. M. PERLMUTTER

With a section on

AN AQUIFER TEST IN DEPOSITS OF GLACIAL OUTWASH

By N. J. LUSCZYNSKI

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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GROUND-WATER GEOLOGY AND HYDROLOGY OF THE MAYNARD AREA, MASSACHUSETTS

By N. M. PERLMUTTER

ABSTRACT

As a part of an evaluation of a proposed reactor site, the Geological Survey, in 1955, at the request of the Corps of Engineers, made a ground-water investigation at and in the vicinity of the Maynard Ordnance Test Station, in northeastern Massachusetts about 22 miles west of Boston. The general investigation covered about 6 square miles but the most detailed study was made in an area of about 1 square mile at the Maynard Ordnance Test Station.

Land surface in most of the area is a plain at an altitude of about 200 feet above sea level. In several places hills composed of till and of bedrock project above the plain to altitudes as high as 320 feet. Ponds and swamps are numerous, several small brooks whose low flow represents ground-water discharge furnish surface drainage.

The three main water-bearing units are glacial outwash, glacial till, and bedrock. The outwash has a maximum thickness of about 100 feet and is composed of beds chiefly of sand and gravel in the upper part, and of silt in the lower part. It is the uppermost unit in most of the area and contains the principal water body. During an aquifer test, a well screened in the outwash yielded about 600 gpm with a drawdown of 17 feet after 50 hours of pumping. The transmissibility, permeability, and storage coefficient of the outwash in the vicinity of the well, as determined by the aquifer test, were about 34,000 gallons per day per foot, about 800 gallons per day per square foot, and about 0.20, respectively.

Till, composed of compact, unsorted boulders, gravel, sand, silt, and clay, is deposited irregularly on the bedrock surface. Owing to its low permeability the till yields only small quantities of water to wells.

The bedrock is composed of igneous and metamorphic rocks of Precambrian(?) and Paleozoic age. It yields small quantities of water from openings along joints, irregular fractures, and cleavage planes. Contours on the surface of the bedrock, drawn largely from seismic refraction data, show a buried valley as deep as 120 feet below the land surface in part of the area.

Contours of the water table show that the ground-water divides are relatively low and broad and that most of the streams and ponds intersect the water table. The depth to water ranges from land surface to about 30 feet below.

Both the ground water and the surface water generally are soft and have a pH of less than 7.0. The natural beta-gamma activity and the radium concentration of the waters are low. The peak daily withdrawal of ground water

within the report area in 1955 was about 612,000 gallons. About 90 percent of the water was pumped from White Pond, a water-table pond, and the remainder mostly from domestic wells.

INTRODUCTION

SCOPE AND PURPOSE

In the spring of 1953 the Geological Survey was asked by the Corps of Engineers, U.S. Army, to make a reconnaissance of the geology and ground water conditions at the Maynard Ordnance Test Station (MOTS) and vicinity for a site-evaluation report. Consideration was being given to establishing a small experimental nuclear reactor, and ground water was to be used for cooling and subsequently returned to the ground.

The Maynard Ordnance Test Station is in the southwestern part of Middlesex County, Mass., about 22 miles west of Boston (pl. 1). It occupies parts of the towns of Hudson, Sudbury, Maynard, and Stow. The part of the test station and vicinity referred to as the Maynard area in this report, is almost entirely within the towns of Sudbury and Hudson; a small part is in the towns of Stow and Marlboro.

The area was examined in May and June, and an administrative report was submitted in July 1953. That report, prepared by E. S. Simpson, pointed out the need for more specific geologic and hydrologic information, particularly with respect to the availability and the direction of movement of ground water. In February 1955 the Geological Survey was requested by the Corps of Engineers to make a more intensive investigation of the ground-water conditions. A program of construction of test and observation wells was laid out, and plans were made for a seismic refraction survey, periodic measurements of water-level fluctuations in observation wells, measurements of stream discharge, and a detailed pumping test in a proposed supply well.

After the fieldwork was completed, a condensed report was submitted to the Corps of Engineers (Perlmutter, 1957). Plans for construction of the reactor installation were abandoned. However, as ground-water conditions in the Maynard area are believed to be representative of those in much of central Massachusetts, it was decided to expand the content and interpretation of the earlier reports and to present all the information in a single published report on the ground-water geology and hydrology. The objectives of this report are to present and to interpret the significant information with respect to (a) extent, thickness, hydraulic continuity, and physical properties of the water-bearing deposits, (b) the configuration of the surface of the bedrock, (c) the direction of movement of the ground water, (d) the quality of the water, and (e) the hydraulic characteristics of the outwash deposits in part of the area as revealed by a pumping test.

METHODS OF INVESTIGATION

Fieldwork began in February 1955 and was virtually completed by the end of September 1955. Initially, the work consisted of extending the inventory of existing wells which had been started by Simpson and others in 1953, examination of the geologic and hydrologic features in the area, and observation of the drilling of five deep test holes by a crew of the Corps of Engineers. Spoon samples of the unconsolidated deposits and cores of the bedrock were taken at each of the test holes. Upon completion of this test drilling, 1¼-inch pipe and well points were installed in the unconsolidated deposits to obtain periodic water-level measurements.

Seismic refraction surveys were made in May and again in September 1955 by the Geological Survey. In the spring of 1955 a recording rain gage was put into operation at MOTS and water-level recorders were installed on two wells. The Geological Survey constructed a temporary gaging station on Marlboro Brook (pl. 1), equipped with a V-notch weir; and established a site for miscellaneous discharge measurements on a small nearby brook. Corps of Engineers personnel installed 28 small-diameter observation wells and the Geological Survey installed 7 similar wells to provide control for a contour map of the water table. Altitudes of measuring points on these wells, of a small number of privately owned wells, and of 39 swamps and ponds were determined by spirit leveling. The Corps of Engineers did most of this work, and also most of the leveling required for the seismic survey.

During July and August 1955 a supply well, 57 feet deep, and 9 nearby observation wells were installed. In September 1955 a 50-hour pumping test was made on the supply well, and water-level readings were taken in 20 observation wells.

Water-level measurements, at monthly or shorter intervals, were made at observation wells, ponds, and swamps throughout the summer and fall of 1955, and continued in selected ones of these until the end of June 1956. At the end of September and during the first week of October 1955 a series of water-level measurements were made in all the accessible wells and ponds, both in and near the test station, for use in the preparation of the contour map of the water table (pl. 1).

ACKNOWLEDGMENTS

The fieldwork and the preparation of the preliminary reports in 1953 and 1957 were done under the immediate supervision of J. E. Upson, formerly district geologist, Mineola district. This report was prepared under the supervision of G. C. Taylor, Jr., district geologist. Henry G. Healy gave considerable help to the writer in the fieldwork.

The Corps of Engineers actively participated by constructing test and observation wells and carrying on most of the spirit leveling, and mechanical (particle-size) analyses of core samples. R. C. Gurley and Charles Maillard of the Corps of Engineers were especially cooperative in supplying data, manpower, and field equipment. David F. Barnes, of the Geological Survey, supervised the seismic work and prepared a report (1956) on the results. Records of precipitation at Gates Pond were provided by the town of Hudson.

SUMMARY OF BASIC DATA

The available new geologic and hydrologic data, together with selected data from the two earlier reports, are presented in tables 1 to 12. Many of the data are illustrated in condensed form in plates 1 to 4 and figures 1 to 7. Tables 1 to 4 give geologic and physical properties of the deposits. Tables 5 and 6 give discharge measurements at the gaging station on Marlboro Brook and on a nearby unnamed tributary. Table 7 summarizes the results of the aquifer test. Table 8 gives chemical analyses of ground and surface water. Table 9 gives the records of wells and test borings in the area and table 10 gives the logs of selected wells and test borings. Table 11 gives individual measurements of water level in selected observation wells; and table 12 gives the measurements of water level at ponds and swamps.

The illustrations show the areal extent (pl. 1), particle-size analyses (fig. 5), and lithologic characteristics (pl. 2) of the water-bearing deposits. Typical seismic data and contours on the bedrock are illustrated in figures 3 and 4, respectively. The altitude of the water table is shown on plate 1 and hydrographs for selected wells and ponds are given on plates 3 and 4 and in figure 6.

WELL-NUMBERING AND LOCATION SYSTEM

Individual wells and test borings are indicated on tables and maps by a number and a location symbol. The wells are numbered serially by towns. All the wells in the report area are in the towns of Hudson, Sudbury, and Stow. Sudbury is indicated by "S", Hudson by "H", and Stow by "St." The wells in the town of Sudbury, for example, are numbered S1, S2, S3, and so on. The letter designating the town is omitted from each well number on plate 1 because the town lines are shown.

Location symbols are used as an aid in finding the wells on the map. These are based on a system (fig. 1) used by the Ground Water Branch in Massachusetts. Each standard 7½-minute topographic quadrangle has been assigned a letter and a number designation. That for the Maynard quadrangle, on which almost all the wells in the report are located, is S/12. This forms the first part of the location symbol. Next, each 7½-minute quadrangle is divided into nine 2½-minute rectangles numbered from left to right and from top to

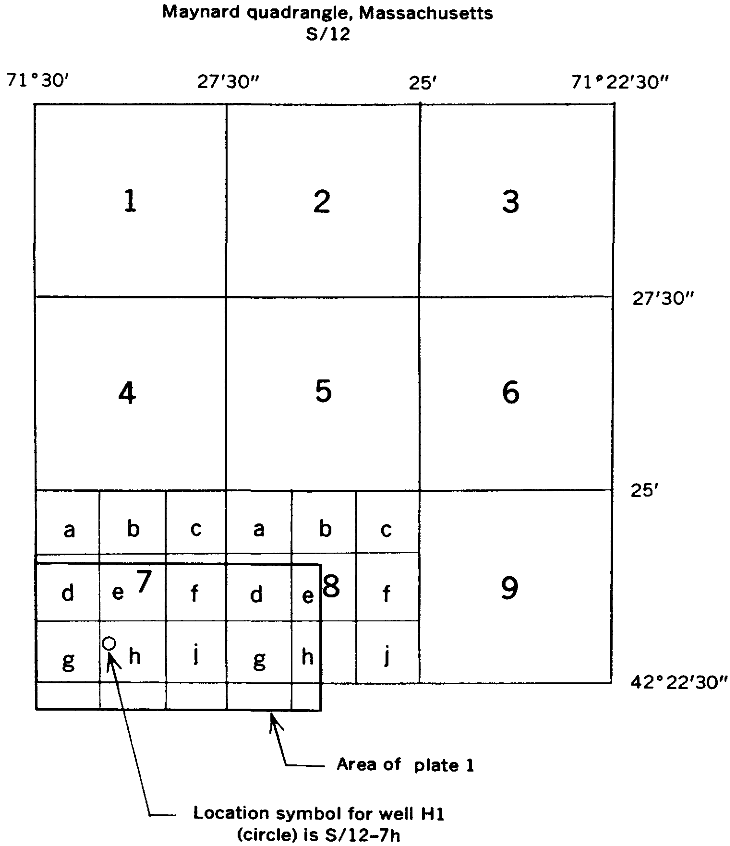

FIGURE 1.—Diagram of location-coordinate system.

bottom, 1 to 9. Each of these 2½-minute rectangles is further divided into nine 50-second rectangles, designated by lowercase letters "a" through "j." The letter "i" is not used.

For an additional example, refer to table 9 and plate 1. The first well on the table is designated H1; it is well number 1 in the town of Hudson. The location symbol is given as S/12–7h. Thus, the well is on the Maynard quadrangle (S/12) and is in rectangle 7, or the southwesternmost of the nine. It is also in the 50-second rectangle "h," which is the south-central subdivision of rectangle 7.

In addition to wells and test borings, plate 1 shows also by means of the symbol "+" the locations of places at which surface-water levels were measured. Location coordinates for these places, given in table 12, are based on the same system as described for wells and test borings.

TOPOGRAPHY AND CLIMATE

The Maynard area lies along the western margin of the Seaboard Lowland section of the New England province (Fenneman, 1938, p. 370-372). The land surface is relatively smooth and subdued, and the major topographic forms are a few scattered hills, which reach altitudes of about 200 to 320 feet, and broad, flat plains, which have altitudes of 190 to 200 feet. The altitude is highest in the hilly southwestern part of the area, and lowest, 150 feet, in a stream valley in the southeastern part. The northwesterly alinement of several hills composed of glacial till (drumlins) contrasts sharply with the northeasterly alinement of hills composed of steeply dipping bedrock strata.

Several small streams that drain the area flow either north to the Assabet River or east to the Sudbury River. During this investigation a temporary recording gaging station was constructed on Marlboro Brook and miscellaneous current-meter readings were made on an unnamed brook nearby (tables 5 and 6). The mean discharge of Marlboro Brook for the period of record was 0.5 cfs (cubic foot per second) and the range of seven miscellaneous readings made on the unnamed tributary was 0.07 to 0.22 cfs. A measurement made on Hop Brook at Dutton Road was 39.8 cfs on April 30, 1953 (E. S. Simpson, written communication, 1953). Numerous swamps, ponds, and undrained depressions cover a substantial part of the plain and are indicative of the poorly integrated drainage found in most glaciated regions. The three largest ponds are Boons Pond, White Pond, and Willis Pond. Boons Pond is an artificial lake created by the damming of a northward flowing tributary of the Assabet River, and White and Willis Ponds are typical glacial kettles. White Pond has been sounded to a maximum depth of about 45 feet.

Hansen (1953, p. 355-357) describes the preglacial and postglacial drainage adjustments in the Assabet and Sudbury basins. Of particular interest to this report is his suggestion that the Assabet River, which now flows northeastward beyond the report area, formerly flowed southeastward to the Sudbury River via a channel which passed through part of the report area occupied by Boons Pond, White Pond, and Hop Brook. The results of test drilling and seismic work conducted for this investigation largely bear out the general pattern suggested by Hansen.

The climate in the Maynard area is of the humid continental variety, modified to some extent by the proximity of the Atlantic Ocean. The average annual precipitation based on long-term records at Marlboro, Concord, and Hudson, Mass., all within 5 to 8 miles from the project area, ranges from about 41 to 43 inches. The lowest annual precipitation reported was about 26 inches at Hudson in 1949 and the maximum was about 59 inches at Marlboro in 1954. The

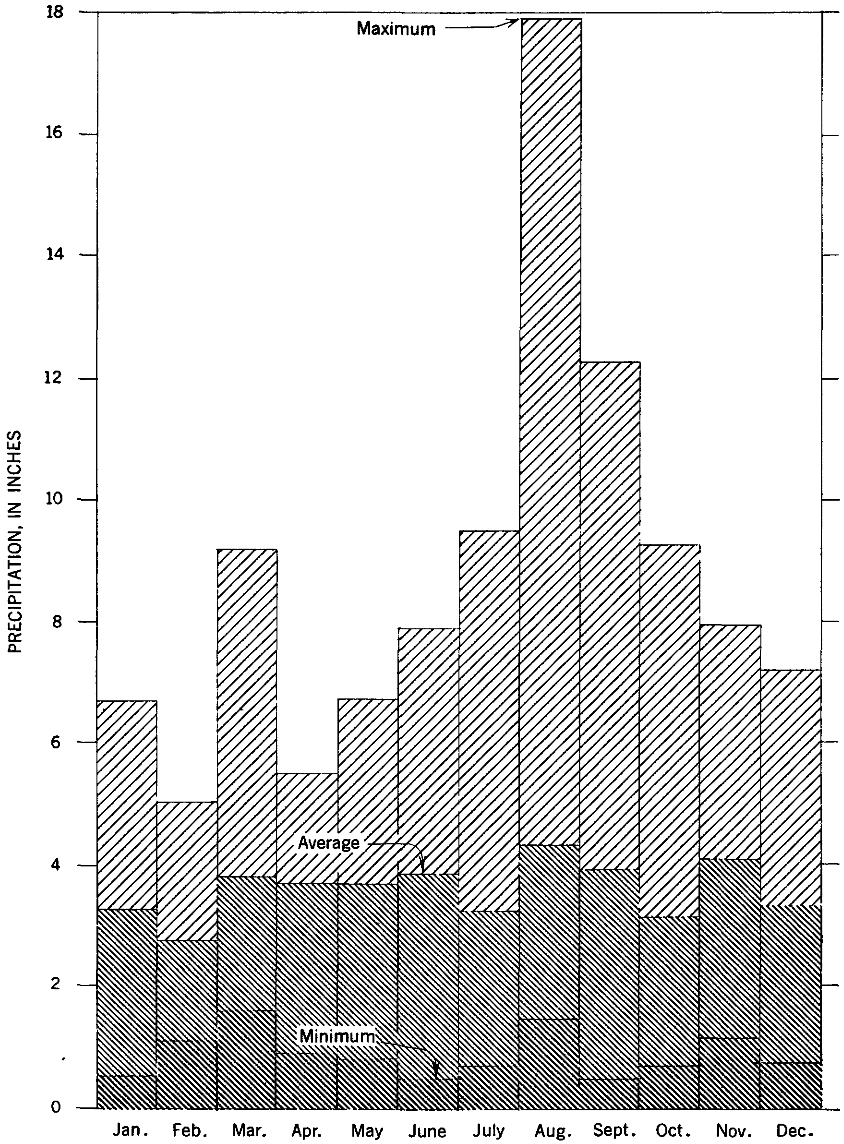

FIGURE 2.—Maximum, average, and minimum monthly precipitation at Gates Pond Station, Hudson Mass., 1933–55.

precipitation is rather evenly distributed throughout the year. The average monthly precipitation ranges from about 3 to 4 inches (fig. 2). In the summer much of the rain comes in brief thunderstorms, and in some years, generally in the early fall, hurricanes deluge the area causing extensive flooding in low-lying areas. For example, during this investigation in August 1955, almost 15 inches of rainfall was recorded at Gates Pond, Hudson, in a period of about 9 days as a result of 2 closely spaced hurricanes. The total for the month was a record high of about 18 inches. The precipitation as recorded by a rain gage at the Maynard Ordnance Test Station during part of this investigation is shown on plate 3.

GROUND-WATER GEOLOGY

SUMMARY OF STRATIGRAPHY AND GEOLOGIC HISTORY

The bedrock formations in the Maynard area consist of igneous and metamorphic rocks of Precambrian(?), Devonian(?), and Carboniferous age. Above the bedrock are deposits of late Pleistocene age laid down as unstratified till by ice and as stratified drift by glacial melt water. Some minor, discontinuous bodies of Recent materials overlie the Pleistocene deposits along stream courses, in swamps, and on some hills. The distribution and character of the bedrock and of the glacial deposits as determined mainly from surface mapping have been described in detail by Hansen (1956). Table 1 is a summary of the lithologic and water-bearing properties of the principal geologic units in the Maynard area. The geologic history summarized below is largely adapted from Hansen (1956, p. 85–96).

The sediments that formed the oldest bedrock unit, the Marlboro formation, were deposited in Precambrian(?) time and consisted of sand, silt, clay, and perhaps some volcanic material. Sometime during the Precambrian these sediments were metamorphosed into schistose rocks. Later, in early Paleozoic time, these rocks were intruded by large bodies of igneous material, which upon cooling formed the Salem(?) gabbro-diorite and the Dedham granodiorite. During Carboniferous time sediments were deposited on the surface of the older rocks and at the close of the period all the rocks were uplifted, folded, and metamorphosed, and schistose and gneissic rocks of the Nashoba formation and the Gospel Hill gneiss were formed.

The uplift in late Carboniferous time was followed by predominantly erosional periods and by Early Cretaceous time the land surface had been reduced to peneplain. During the Tertiary renewed uplift and extensive erosion occurred. The first major streams developed on the newly uplifted surface were of the consequent type and generally ignored the structure of the bedrock, but many tributary streams followed the northeastward-trending belts of relatively soft rock and thus developed a regional trellis drainage pattern. Dissection of the Cretaceous peneplain was completed by late Pliocene time, and an irregular bedrock surface was exposed to the ice sheets during the subsequent Pleistocene epoch.

TABLE 1.—*Generalized section of the geologic units, Maynard area, Massachusetts*

System	Series	Geologic unit	Maximum thickness (feet)	Lithologic properties	Water-bearing properties
Quaternary	Recent	Recent deposits	4±	Peat and gray silt; wind-deposited brown fine to medium sand; and alluvium composed of brown fine to coarse sand and gravel.	Not a source of water, owing to thinness, limited distribution, and, in places, low permeability. Fine-grained deposits retard movement of water.
	Pleistocene	Outwash	100±	Upper part consists of brown fine- to coarse-grained sand and gravel. Lower part consists mostly of very fine sand and silt, and some beds and lenses of medium- to coarse-grained sand. A deep body of coarse sand and gravel, bordered by fine-grained material, apparently is a channel-filling deposit.	Principal aquifer. The upper coarse-grained beds are highly permeable and are the main source of supply for domestic wells. A test well consisting of an open-end casing, 2 inches in diameter, yielded 60 gpm (gallons per minute). A well at the Maynard Ordnance Test Station, screened in a deep body of coarse-grained outwash, yielded 600 gpm with a drawdown of about 17 feet after 50 hours of pumping. The fine-grained beds of outwash contain some water, but owing to their low permeability they yield only small amounts of water through dug wells.
		Till	100±	Boulders, gravel, and sand, silt, clay, unstratified, compact, grayish-green. Weathered deposits are brown. Generally occurs beneath outwash as an irregular layer on buried bedrock surface, as discontinuous patches of different thickness in areas where the bedrock surface is at shallow depths, and as thick, elongate bodies, in the form of drumlins, bordered by outwash.	Not an important source of water. Saturated below the main water table but owing to low permeability transmits water very slowly. Yields a few gallons a minute through large-diameter dug wells for domestic use.
	Unconformity				
Carboniferous, early Paleozoic(?), and Precambrian(?)		Bedrock (Includes from youngest to oldest: Gospel Hill gneiss, Nashoba formation, Dedham granodiorite, Salem(?) gabbro-diorite, and Marlboro formation.)	Unknown	Igneous and metamorphic rocks including gabbro-diorite, granodiorite, aplite, granite, amphibolite schist, and gneiss. Foliation and lineation poorly to well developed. Colors are dark gray or green, and some light gray and pink.	Not an important source of water. Permeability generally very low. Contains some water along openings in joints, and along cleavage and fault planes. Yields generally are less than 10 gpm. Supplies water for domestic use at a few places.

Although ice sheets probably occupied the area several times, only deposits of the latest, or Wisconsin, stage are recognizable. The ice sheets covered hills and valleys alike. The bedrock was grooved in some places and polished in others, and huge blocks of rock, torn from hillsides, were transported southward in the moving ice. An irregular blanket of unsorted rock debris was laid down on most of the bedrock surface by the ice. During the melting or retreatal stage of glaciation, beds of sand, gravel, silt, and clay were deposited extensively in the lowlands and valleys, which were intermittently occupied by glacial streams and by glacial lakes. Alternate periods of slight readvance, stagnation, and retreat of the ice front, formation of several large glacial lakes, deposition of assorted glaciofluvial and glaciolacustrine material, and numerous drainage modifications were characteristic of the last part of the glacial history. Since the melting of the ice, small flood plains have been formed along a few streams, thin soil and other organic deposits have accumulated on the glacial deposits in places, and some minor stream erosion has taken place.

CONSOLIDATED ROCKS OF PRECAMBRIAN(?) AND PALEOZOIC AGE

The bedrock beneath the Maynard area consists of igneous and metamorphic rocks which have been mapped and described by Hansen (1956) as five distinct formations. From oldest to youngest these are: (a) the Marlboro formation, a grayish-green schist of Precambrian(?) age which underlies the central third of the area; (b) the Salem(?) gabbro-diorite, a dark-greenish-gray medium- to coarse-grained rock of early Paleozoic age which underlies most of the eastern third; (c) the Dedham granodiorite, a light-gray medium-grained rock also of early Paleozoic age which underlies the extreme southeastern corner of the area; (d) the Nashoba formation, a light-gray gneiss of Carboniferous age which underlies a small part of the western third; and (e) the Gospel Hill gneiss, a gray to pink coarse-grained gneiss of Carboniferous age which underlies most of the western third.

The bedrock formations represent the core and the northwestern limb of a northeastward-plunging asymmetrical anticline; consequently the formations trend northeastward in belts of varying width (Hansen, 1956, pl. 1). The rocks are closely folded and dips are steep. Joints are common in the outcrops of bedrock and presumably occur at depth in the rocks beneath the glacial deposits. The joints are mostly vertical or nearly vertical and generally trend northwestward. No surface or subsurface indications of major faults were noted in the bedrock. The Marlboro formation and the Gospel Hill gneiss crop out in a few places (pl. 1), but in most of the area the bedrock is covered by glacial deposits, ranging in thickness from a featheredge to about 120 feet, and beneath these places the boundaries of the formations have been inferred. Five test holes penetrated the buried surface of the bedrock in the Maynard Ordnance Test Station. Four of these holes, H7, S111, S112, and S114 (table 10) penetrated schist of the Marlboro formation. The fifth hole, S113, penetrated a pink coarse-grained rock of granitic composition which may represent a small isolated body of aplite similar to that mapped by Hansen at an outcrop about half a mile east of the east border of the report area.

All the bedrock formations are dense and hard and virtually lack primary openings such as the pore spaces in unconsolidated deposits. The water is contained mainly in openings along joints and to a lesser extent in openings along cleavage planes and irregular fractures. These openings are a minor source of water, as yields from most wells in bedrock are low. Records for only a few wells were obtained. For example, well H6 on Parmenter Street (pl. 1) in the southwestern part of the area is 95 feet deep and penetrates the Gospel Hill gneiss. The well has a reported yield of 3 gpm. The static water level in the well is reported to be about 30 feet below the land surface and the pumping level about 95 feet. Well S107 is in the test station on the north side of Hudson Road and penetrates the Marlboro formation. It is about 150 feet deep and the static water level is about 24 feet. The well supplies a small quantity of water for domestic use but its yield is unknown. Well H16 on Concord Road, a short distance south of the Boston and Maine Railroad, is 53 feet deep and is drilled entirely in the Marlboro formation, its reported yield is 7 gpm.

In parts of the area the bedrock either gains some water from or loses water to the overlying deposits, according to the relative heads in the water-bearing units. Although the bedrock contains some water, the configuration and depth of its surface have a greater bearing on the ground-water conditions than do its water-yielding characteristics.

BEDROCK SURFACE

The depth and configuration of the bedrock surface and the altitude of the water table are the principal elements in estimating the saturated thickness of the unconsolidated deposits, determining the direction of movement of the ground water, and selecting potential sites for deep supply wells. Field examination of the few outcrops of bedrock and the results of five test holes suggested that the surface was highly irregular and that much additional information was needed, particularly with respect to the occurrence, depth, and alinement of buried channels on the bedrock surface. The seismic method was chosen as the quickest and most economical means of obtaining the additional information, as the character and stratification of the deposits seemed to be ideally suited for such exploration. Accordingly, during April and September 1955, seismic refraction surveys were made both within and along the perimeter of the MOTS, and along Hudson and White Pond Roads to the West.

The procedure and results of the seismic work given below are adapted largely from an open-file report on those surveys by D. F. Barnes (1956). The general theory of seismic refraction surveying is explained in detail in most textbooks on geophysical prospecting and is outlined only briefly in the next section.

SEISMIC REFRACTION SURVEY

Seismic refraction surveying is based largely on the principle that part of the sound waves generated by an explosion near the land surface are refracted or bent at the boundaries of rocks having different elastic properties. Because the modulus of elasticity of crystalline rocks is much greater than that of unconsolidated deposits, sound energy in crystalline rocks may travel at a speed 30 times faster than that in unconsolidated deposits. (See table, p. E–14.) Too, compaction causes an increase in elasticity; thus, sound travels faster in compact till than in loose sand and gravel.

Sound energy refracted at the deeper surfaces of high-velocity rocks will reach distant points at the land surface before the energy which travels nearly horizontally and directly through the overlying low-velocity deposits to the same points. Detectors or geophones placed along a straight line on the ground away from the point of explosion are used to pick up the arrival of successive waves. The arrival time of the first wave is most significant and is used in calculating the velocity of sound in and the depth to the top of each layer.

Most of the seismic traverses or spreads in the Maynard survey covered a linear distance of 550 feet, and the overlap between successive traverses was 150 feet. The first detector was set 25 feet from the shot point. The second was set 25 feet from the first, and the rest of the 10 detectors were set 50 feet apart. The shotholes were 2 to 4 feet deep, and generally half a pound or more of dynamite was exploded in each hole. Both the instant of firing and the trace of the sound waves picked up by each detector were recorded on photographic paper at the seismograph. The record of the sound waves (the seismogram) was developed immediately after each firing.

After a shot had been fired at one end of a detector spread, the positions of the shothole and the most distant detector were interchanged, and another shot was fired at the other end of the spread. Thus the velocity of sound traveling in both directions along each spread could be measured and adjustments made in the velocity and

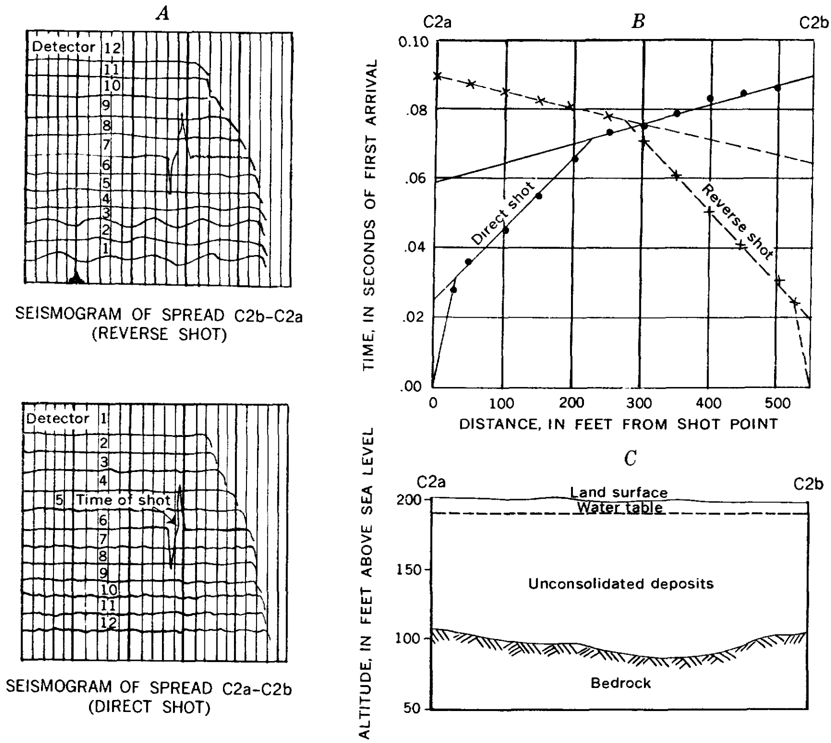

FIGURE 3.—*A*, Typical seismograms; *B*, travel-time curves; *C*, profile based on seismic data; Maynard Ordnance Test Station, Massachusetts. (After Barnes, 1956.)

depth calculations to take into account any appreciable slope of the refracting surfaces. Figure 3*A* shows a typical pair of seismograms obtained from a direct shot and a reverse shot along Diagonal Road west of the railroad tracks at the Maynard Ordnance Test Station. The vertical time lines on the seismograms represent an interval of 0.01 second, and the nearly horizontal lines are the traces of the impluses recorded at each of the 12 detectors. The uppermost trace is that of the detector nearest the shot point. The first part of each trace is the prefiring portion, which may show background noise caused by wind, moving vehicles, persons walking about, and other ground disturbances. The time of the first arrival at each detector is indicated by the abrupt downward trend of the trace on the seismogram; the subsequent waves have a much larger amplitude and are not shown on the illustration as they serve no useful function.

After the time of the first arrival was picked off each seismogram, travel-time curves were prepared for each direct and reverse spread by plotting the time of the first arrival versus the distance of the detector from the shothole. Figure 3*B* shows travel-time curves for the direct and reverse shots whose seismograms are illustrated in figure 3*A*. The changes in slope of the travel-time curves reflect changes in the velocity of sound as it passes from one type of material to another. The table below gives the velocity of sound in different materials in the Maynard area. Most of the travel-time curves had three segments interpreted generally as unsaturated unconsolidated deposits, saturated unconsolidated deposits, and crystalline bedrock. The depth of each layer was computed from a combination of the delay-time techniques of Nettleton (1940), Barthelmes (1946), and Pakiser and Black (1955). The computations are based on relatively simple trigonometric formulas derived from Snell's law of refraction (Nettleton, 1940, p. 240).

In most of the area, till intervenes between the outwash and bedrock; but, except in a few places where it is relatively thick with respect to the outwash, the till was not thick enough to be revealed by the seismic records. Although the traverses crossed at least three bedrock formations of different lithology, the seismic records apparently failed to show any systematic variations in velocity that could be related to the differences in the character of the rock (Barnes, 1956, p. 4–5).

Velocity of seismic-wave propagation in different materials in the Maynard area, Massachusetts

[After Barnes (1956)]

Material	Velocity	
	Range (feet per second)	Average (feet per second)
Outwash:		
Unsaturated	700–1, 500	1, 000
Saturated	4, 500–6, 000	5, 500
Till:		
Unsaturated	2, 000–3, 000	----------
Saturated	6, 000–8, 000	----------
Bedrock	12, 000–20, 000	17, 000

CONFIGURATION OF THE BEDROCK SURFACE

A somewhat subdued topography of northeastward-trending low ridges and broad valleys and probably a modified trellis drainage pattern were developed on the bedrock surface prior to Pleistocene glaciation. The approximate drainage pattern as envisaged by Hansen (1953, p. 356–357) called for the main valley of the Assabet River to trend southeastward across the area via Boons Pond, White Pond, and the downstream reach of Hop Brook. The seismic survey, together with data from the test holes that were drilled to bedrock, has resulted in only a slight modification of this picture.

Figure 4 is a contour map showing the bedrock surface beneath the

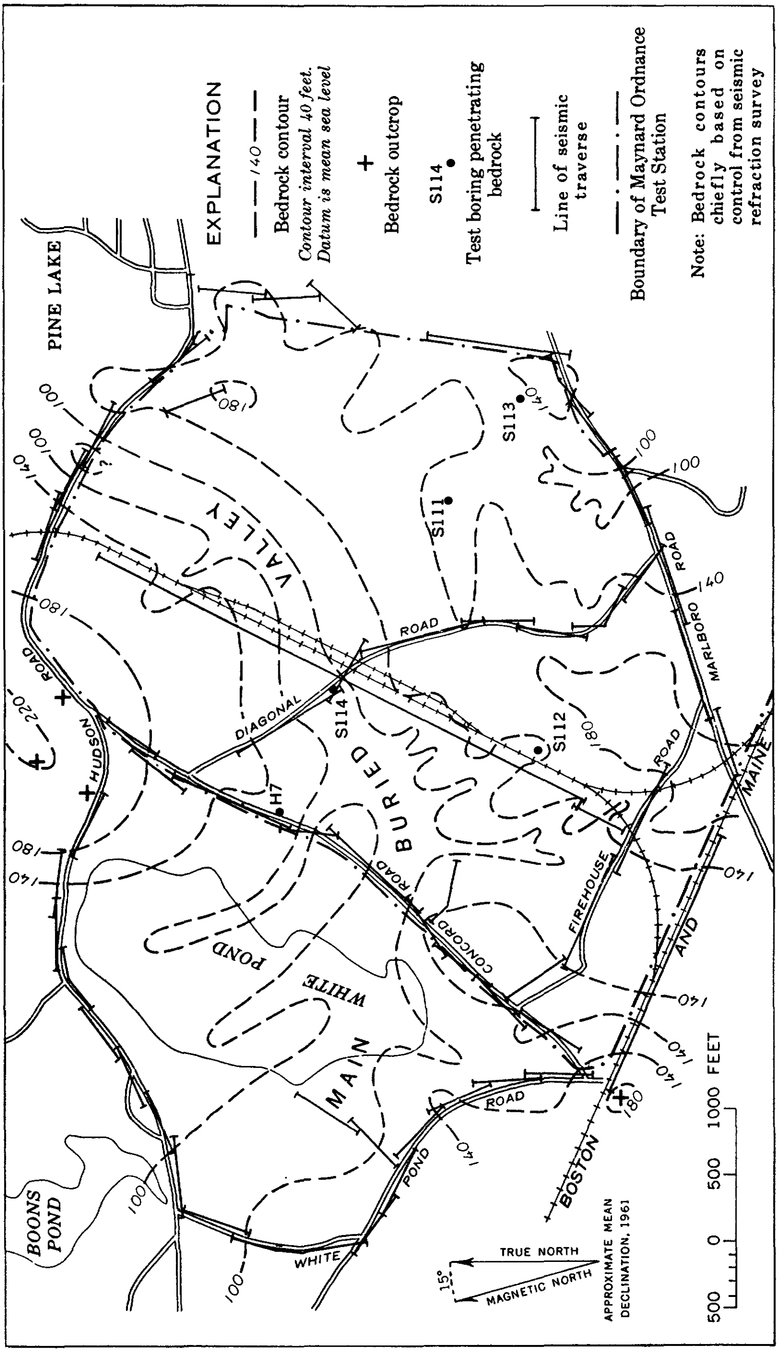

FIGURE 4.—Contours on the bedrock surface, Maynard Ordnance Test Station and vicinity, Massachusetts.

central portion of the area of the investigation, including the Maynard Ordnance Test Station proper. The area mapped extends between Hudson Road on the north and the Boston and Maine Railroad tracks on the south; and Boons Pond on the west to the MOTS fence line on the east.

The base for the contour map was prepared from a map showing the seismic spreads in the report by Barnes (1956). To prepare the contour lines shown, altitudes of points on the bedrock surface were taken from seismic profiles and considered together with altitudes of points on the bedrock surface obtained from 5 test borings and from a few outcrops of the bedrock. Contours on the land surface were taken from maps of the Corps of Engineers. Calculated thicknesses of unconsolidated deposits from seismic data are as much as 120 feet. The thickness of unconsolidated deposits, according to the seismic data, is greatest in the central part of the area about midway between Concord Road and the railroad-classification yard within MOTS (fig. 4) and in the northwestern part of the area near the intersection of Hudson and White Pond Roads.

The significant features shown by the contour map and by the profiles of Barnes' report are:

1. The surface of the bedrock is relatively deep and irregular beneath most of the area. Bedrock is at shallow depths or crops out near the intersection of Concord and Hudson Roads in the north-central part of the area and along White Pond Road and the Boston and Maine Railroad in the south-central part of the area.
2. A fairly well defined bedrock valley extends southeastward from Boons Ponds to a short distance beyond Concord Road, and then turns northeastward to cross Hudson Road west of Bottomless Pond. From there it probably trends southeastward into Hop Brook. The floor of this valley is about 85 feet above sea level at its maximum depth. The thickest unconsolidated water-bearing deposits occupy the deepest part of this valley.
3. A low ridge on the bedrock surface rises a little more than 40 feet above the level of this valley bottom, and extends northeastward between Hill 210 and Hill 235. The alinement of the ridge roughly parallels the inferred contact between the Salem(?) gabbro-diorite and the Marlboro formation (Hansen, 1956, pl. 1). Similarly, the northeastward trending part of the main valley in the bedrock conforms to the regional northeastward strike of the bedrock.
4. The ridge between Hill 210 and Hill 235 is not very high, but as shown on section *A–A′* it accounts for an appreciable thinning of the overlying water-bearing deposits. The ridge is shown as a slightly irregular surface in the vicinities of wells S111 and S113

on section *A–A′* (pl. 2). The saturated water-bearing deposits over this ridge are 45 to 50 feet thick, whereas in the deeper part of the trough to the west, as in well S114, the saturated deposits are about 80 feet thick. This ridge may retard the eastward movement of ground water, and help to maintain the broad, flat water-table divide beneath the central part of the MOTS.

UNCONSOLIDATED DEPOSITS OF PLEISTOCENE AND RECENT AGE

TILL

Till is a compact, unsorted mixture of clay, silt, sand, gravel, and boulders deposited directly by the ice sheet. It rests on the bedrock, and in most of the area is covered and concealed by outwash. The till forms both ground moraine and drumlins.

As ground moraine, the till forms an irregular, but probably nearly continuous, blanket on the bedrock surface. It ranges from a few inches to at least 40 feet in thickness. The ground moraine (fig. 1) is exposed at the land surface in only a few places where it rises above the level of the outwash. These places mark points where the bedrock is relatively close to the land surface.

At a few places the till is much thicker and forms prominent hills whose long axes have a crude northwesterly alinement. Such hills composed of till are called drumlins (pl. 1). Hansen (1956, pl. 2) mapped one large drumlin, Hill 286, near the west edge of the MOTS area, and mapped several other smaller hills as ground moraine. However, some of these smaller hills also appear to be drumlins, partly buried by outwash, and are so mapped on plate 1 of this report. For example, Hill 210 in the southeast corner of the MOTS, according to the seismic survey, is composed entirely of till which is about 60 feet thick. Similarly, Hill 235, in the northeastern part of the MOTS, also is composed mostly of thick till, but it may have a bedrock core. According to the seismic data, bedrock is relatively high beneath the east-central part of the hill but lies deeper on the northwest side, where the overlying till is about 80 feet thick. Test boring S109 on Hill 235 (pl. 1, table 9) penetrated about 35 feet of till without reaching bedrock. Both Hill 210 and Hill 235 are considered drumlins because they have a northwesterly alinement and are composed chiefly of till.

The till in the MOTS area is a poorly sorted mixture of fine to coarse sand and silt and some clay and gravel. Locally it may contain lenses of stratified material. The poor sorting of the till is indicated by the gradual slope of the cumulative curves of the mechanical analyses (fig. 5*A*) for samples of till from five wells, and by the large content of silt shown by the mechanical analysis (table 2) of a sample of till dug a few feet below the top of Hill 210. The soil zone above the till on Hill 210 is similar in composition but contains less gravel

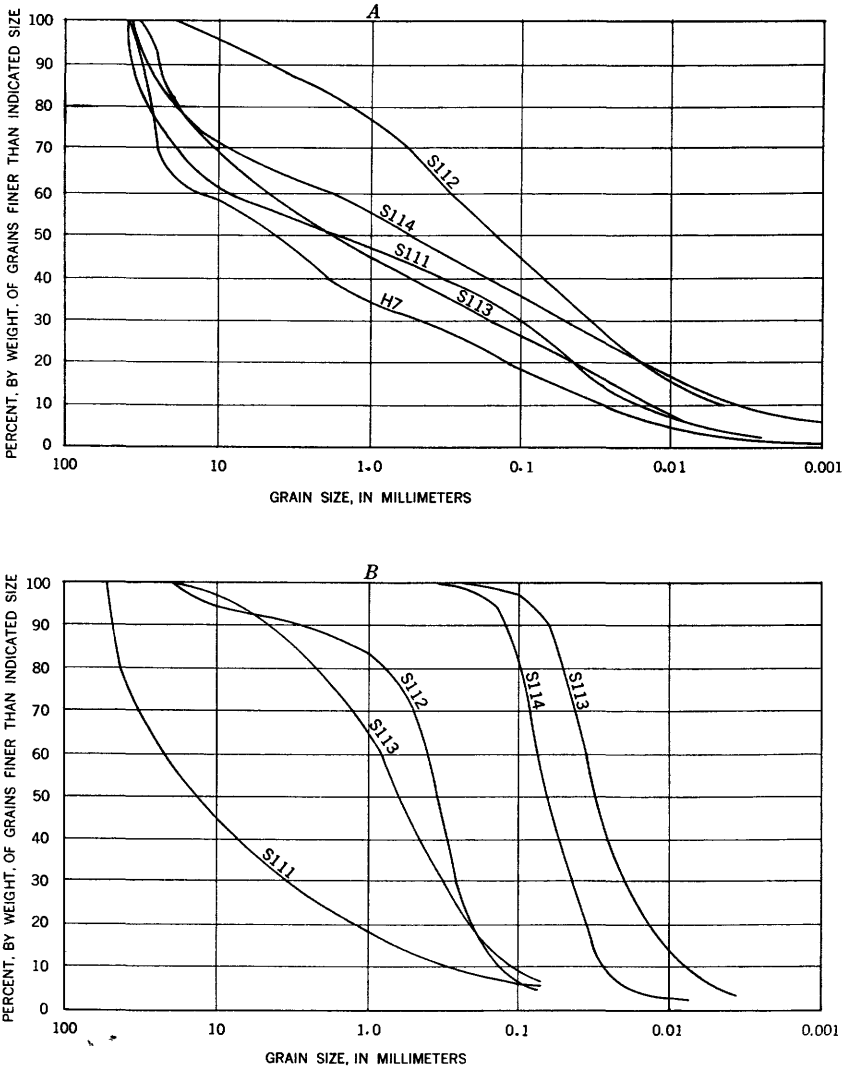

FIGURE 5.—Cumulative curves showing grain size and sorting characteristics of till (*A*) and outwash (*B*), Maynard Ordnance Test Station, Massachusetts. (Data from Corps of Engineers, U.S. Army.)

and more organic material than the till (table 2). In the samples of till analyzed by the Corps of Engineers, the combined silt and clay content ranged from about 15 to 40 percent by weight and the gravel content from about 10 to 50 percent. The uniformity coefficient (table 3) for the samples whose mechanical analyses are shown in figure 5*A* averages 412 and the effective size averages 0.013 millimeter. The high uniformity coefficient is an index of the poor sorting and probably also of the low porosity and permeability of the till.

Most of the till is light gray to grayish green. Compact gray till was penetrated beneath the outwash in the five deep test holes put down by the Corps of Engineers. In a few places where the till crops out, the upper part commonly is grayish brown. Brown and grayish-brown till was reported in shallow test holes S108, S109, and S110. The brownish color may be due entirely to weathering, but it also may represent evidence of the presence of till of more than one glacial stage.

TABLE 2.—*Mechanical analyses of soil, till, and outwash, Maynard Ordnance Test Station, Massachusetts*

[Analyses by U.S. Geological Survey]

Grain size (millimeters)	Name	1A	1B	4A	4B
		Percent by weight			
>2.0	Gravel	5.86	21.63	1.24	5.33
2.0–1.0	Very coarse sand	3.37	4.68	2.06	2.98
1.0–0.5	Coarse sand	9.56	7.98	12.06	14.21
0.5–0.25	Medium sand	19.62	10.20	39.80	43.63
0.25–0.1	Fine sand	17.40	13.28	27.08	23.18
0.10–0.05	Very fine sand	10.60	10.34	5.67	3.12
0.05–0.002	Silt	28.82	28.64	7.80	5.27
<0.002	Clay	4.75	3.24	4.28	2.26
Organic matter [1]		7.3	1.2	3.9	2.0

[1] Loss on treatment with sodium peroxide.

1A, upper part of soil horizon above till; top of Hill 210, MOTS.
1B, till, 3 feet below land surface; same location as 1A.
4A, upper part of soil horizon above outwash; near Marlboro Brook and Marlboro Road, MOTS.
4B, outwash, 4 feet below land surface; same location as 4A.

TABLE 3.—*Uniformity coefficient and effective grain size of representative samples of glacial till and outwash, Maynard Ordnance Test Station, Massachusetts*

[Data from Corps of Engineers, U.S. Army]

Well	Depth of sample (feet)	Description	Uniformity coefficient [1]	Effective size [2] (millimeters)
		Till		
H7	66–70	Silty, sandy gravel	536	0.028
S111	60–65	do	594	.016
S112	60–62	Gravelly, silty fine to coarse sand	67	.004
S113	65–67	Silty, sandy gravel	364	.014
S114	95–99	Sandy, silty gravel	500	.004
		Outwash		
S111	45–50	Silty, sandy gravel	70	0.30
S112	10–15	Fine to coarse sand, some gravel	3	.13
S113	2–4.5	do	6.7	.12
S113	28–30	Silt, trace of fine sand	4.6	.008
S114	61–65	Sandy silt	2.6	.027

[1] Uniformity coefficient is the ratio of the diameter of a grain that is coarser than the finer grained 60 percent (by weight) of the sample to the diameter of a grain that is coarser than the finer grained 10 percent (after Meinzer, 1923, p. 7).
[2] Effective size of grain is the diameter of a grain of such size that 10 percent of the sample (by weight) consists of smaller grains and 90 percent of larger grains (Hazen, as cited in Meinzer, 1923, p. 7).

Till is composed of a variety of rock and mineral fragments. The gravel and sand fraction consists largely of quartz, and some biotite, muscovite, and fragments of igneous and metamorphic rocks. The mineralogy of the silt and clay fraction of a sample of till and of the overlying soil is shown in table 4. The analysis was made chiefly by X-ray diffraction. The silt fraction in both materials consists chiefly of quartz, whereas the clay fraction consists mostly of hydrous mica and chlorite. An unidentified kaolin mineral also is abundant in the clay fraction of till but is subordinate in the clay fraction of the soil.

The mineral composition of the soil and of the underlying till has a direct bearing on their ability to modify the chemical composition of solutions passing through them by physical and chemical adsorption of selected constituents from the solutions. The physical process depends chiefly on the surface area per unit volume of the solid medium, and the nature of both the solid and nonsolid substances. The chemical process, termed "ion exchange," involves the substitution of a foreign cation and anion from an aqueous solution for a cation or anion in a surrounding solid medium. The ion-exchange capacity is expressed in milligram equivalents of exchangeable ions per 100 grams of earth material. The exchange is thought to occur mainly at the surfaces of colloidal particles of minerals, especially clay minerals, and organic matter (Robinson, 1949, p. 151–152).

The ion-exchange capacity of a sample of the soil above till at the Maynard Ordnance Test Station is about 3.7 meq per 100 g (milliequivalents per 100 grams) and that of the underlying till is about 1.5 meq per 100 g (table 4). These values are similar to those determined for a sample of soil and the underlying outwash (table 4) at the test station. An ion-exchange capacity of 1 meq per 100 g is considered to be moderate (E. S. Simpson, written communication, 1953).

Ion-exchange capacity is an important characteristic in evaluating the ability of earth materials to retard the movement of dissolved contaminants such as the products of radioactive fission. The data on hand show that the ion-exchange capacity of the soil zone at MOTS is more than three times higher than that of the underlying till and outwash. For the samples analyzed the ion-exchange capacity of the till was only slightly higher than that of the outwash.

The compactness of the till is indicated by the high hammer-blow count in driving pipe through it. For example, in some of the holes, the number of blows per foot of penetration of a spoon sampler driven by a 300-pound hammer was as much as 400 for some intervals. This contrasts with 30 blows or less for outwash. Because of its compactness and poor sorting, till has low permeability and water moves very slowly through it in most places. The amount of available water in till is small and mostly is stored in thin sandy lenses. Thus, only a few privately owned wells obtain water from the deposits, and these are shallow, large-diameter dug wells. They are used for domestic supplies, and are equipped with pumps that produce water at the rate of a few gallons per minute intermittently. No precise data are available on the fluctuations and altitude of the water table in till. In many places the seasonal range in water levels in till is several times as great as that in outwash. Low water-table mounds probably underlie the hills composed both of till and of bedrock. The approximate depth to water in the till beneath Hills 210 and 235, as estimated from seismic data in 1955, is sketched on section B–B′ (pl. 2).

TABLE 4.—*Geochemical properties of soil, till, and outwash, Maynard Ordnance Test Station, Massachusetts*

[Analyses by U.S. Geological Survey. For description of samples and location, see table 2. P, predominant; S, subordinate; Tr, trace; 5, approximate percent]

	Soil (1A)	Till (1B)	Soil (4A)	Outwash (4B)
Total ion-exchange capacity (meq per 100 g)	3.7	1.5	3.4	1.0
Silt fraction				
Quartz	P	P	P	P
Feldspar	S	S	P	S
Mica	S	S	--------	S
Biotite	--------	--------	S	--------
Chlorite	--------	--------	S	S
Kaolin mineral	--------	S	S	--------
Sillimanite	--------	--------	S	--------
Hornblende	--------	--------	S	--------
Clay fraction				
Chlorite	P	--------	--------	--------
Hydrous mica	P	P	P	P
Kaolin mineral	S	P	P	P
Hydrobiotite(?)	--------	S	--------	--------
Vermiculite(?)	--------	--------	S	--------
Chlorite	--------	--------	--------	S
Quartz	T	T	5	5
Feldspar	T	T	5	5

OUTWASH

The most productive, and most readily accessible, of the water-bearing deposits is the outwash. Disregarding the soil zone and thin deposits of Recent age, it is the uppermost deposit in most of the area, and generally forms a broad plain locally trenched by streams and pitted by shallow depressions containing lakes or swamps (pl. 1).

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The outwash is of two major types: proglacial deposits and ice-contact deposits. Proglacial deposits, in the form of broad outwash plains, and deltaic and bottom deposits in lakes, were laid down by melt-water streams issuing from the ice margin. The stream deposits are fine to coarse textured and well stratified in most places, and form the upper 20 to 30 feet of the outwash. Beneath the upper relatively coarse grained zone is a lower zone composed chiefly of beds of gray very fine sand and silt and some scattered lenses of coarse material. These lower beds are as much as 55 feet thick in some places, and are chiefly lake-bottom deposits.

The ice-contact deposits were laid down by glacial streams in tunnels or crevices in the ice, forming elongated mounds called eskers, and against the ice or in holes in the ice, forming roughly circular hills called kames. The stratification of the deposits ranges from poor to good, and the grains range from clay to cobble gravel in size. Two eskers are present near the southwest end of White Pond and two near the east end of Boons Pond. A large kame makes a conspicuous hill near well S53 on the south side of Willis Pond, and a few smaller kames occur in the southeastern part of the area in the valley of Hop Brook. All these features have been mapped in detail by Hansen (1956, pl. 2), but in this report they are included in the general unit designated "outwash" (pl. 1).

The outwash is overlain by thin, discontinuous threads of alluvium, by swamp deposits, and by some eolian sand. It in turn lies upon or against till which everywhere, so far as is known, intervenes between the outwash and the bedrock. The thickness of the outwash ranges from a featheredge to about 100 feet and averages about 50 feet.

At the few accessible exposures examined the uppermost outwash consists mostly of medium to coarse sand and gravel. However, some of the kames, such as the small hill at the south side of Willis Pond, consist chiefly of very coarse sand, gravel, and boulders. The variation in the type of material and sorting of the outwash at depth is indicated by the logs of wells (table 10), which are based in part on examination of cores and samples from wash borings. The cumulative curves of the mechanical analyses for five samples of outwash are shown in figure 5*B*, and the uniformity coefficient and the effective grain size for the same samples are given in table 3. The cumulative curve for S112 and the nearby curve for S113 are representative of the sorting of the uppermost beds of outwash.

The sorting of the lower beds is represented by the curve for S114 and the nearby curve for S113 (fig. 5B). Some of these beds contain as much as 95 percent of silt-size particles. The fine texture and uniform grain size of the deposits are indicated by the small effective size of grain and the low uniformity coefficient (table 3). At several places these fine-grained deposits extend to the bottom of the outwash and rest directly on till. Although the lower part of the outwash is generally fine grained, locally as at well H7 (table 10, pl. 2) in west-central MOTS it contains thin lenses of medium- to coarse-grained sand and gravel in the lower part. At well S112 (table 10) in south-central MOTS, the lower fine-grained beds are absent, and about 21 feet of coarse-grained outwash rests directly on till.

One well, S111 (pl. 2), in east-central MOTS, after passing through the upper zone of fine- to coarse-grained outwash, continued in coarse material to the bottom of the outwash at a depth of 58 feet. The material was so coarse-grained that the supply well at MOTS was located in it. The mechanical analysis of a sample from the screen zone is represented by the curve for S111 (fig. 5*B*). This lower body of coarse-grained material is unusual at this depth and may be a channel filling, or perhaps a body of ice-contact deposits surrounded by fine-grained beds. If the former, it may extend some distance as a linear body, if the latter it would probably be local in occurrence. In either case, more precise knowledge of the orientation, extent, and dimensions of the deep coarse-textured body would be of value in locating other productive wells and in estimating the hydraulic characteristics of the outwash.

In the Pine Lake settlement northeast of MOTS (pl. 1) a few wells in the outwash are reported to pass through clay beds as much as several feet thick. These are reported to be overlain and underlain by sand and gravel. An example of such interbedding is given in the log of well S50 (table 10). The clays, probably glaciolacustrine in origin, are not penetrated by all wells in the area, as they are probably lenticular.

Sand- and gravel-size constituents of the outwash consist of quartz and particles of various types of crystalline rocks. Silt-size particles are mainly quartz and feldspar and subordinate amounts of muscovite, chlorite, and biotite (table 4). Clay-size particles consist of hydrous mica and kaolin and subordinate amounts of quartz and feldspar. The ion-exchange capacity of the outwash and of the overlying soil is similar to that of till and its overlying soil (table 4 and p. E–20).

The water-yielding properties of the outwash vary with difference in lithologic character. The upper coarse-grained zone has the highest permeability and is tapped by many dug wells and well points (table 9), but not much water is pumped from individual wells. A test well in MOTS consisting of an open-end casing, 2½ inches in diameter, yielded about 60 gpm at a depth of 40 feet in the outwash near well S115.

During an aquifer test in September 1955, well S115, screened from 37 to 57 feet below the land surface in the lower body of coarse-grained outwash, yielded about 600 gpm with a drawdown in the pumped well of about 17 feet after 50 hours of pumping. This represents a specific capacity of about 32 gpm per foot of drawdown. A detailed discussion of the aquifer test is given on pages E32–E39. The fine-grained beds of outwash contain a considerable quantity of water which can percolate slowly into adjoining coarse-grained beds, but the fine-grained beds do not readily yield water to wells owing to their low permeability.

RECENT DEPOSITS

The Recent deposits are relatively thin and restricted in distribution. They consist of alluvium composed of reworked outwash sand and gravel deposited along the courses of several small streams, of gray organic silt and peat deposited on lake bottoms and in swamps, and of loesslike deposits of uniform brown fine sand that are found as a mantle several feet thick on top of several of the hills. None of these deposits have any importance as sources of water. The peat and organic silt locally retard movement of water into or out of the outwash.

GROUND-WATER HYDROLOGY

Precipitation, which averages about 42 inches per year, is the principal source of ground water. Part of the precipitation runs off over the land into streams and ponds, part is stored in the soil and is used by plants, part is evaporated directly from open bodies of water, soil, and plant surfaces, and the rest seeps downward through the soil zone and the underlying zone of aeration, and ultimately reaches the water table (top of the zone of saturation). Water that reaches the zone of saturation is referred to as "ground-water recharge." In the zone of saturation the water moves slowly to points of natural discharge. In much of the Maynard area the water table is at relatively shallow depth, and it crops out in many places as seeps or springs. Thus a substantial amount of ground water is discharged by direct evaporation from water-table ponds and swamps, and through transpiration by plants whose roots tap the water table. Some ground water also is lost through natural discharge into several small streams whose bottoms are cut below the water table (tables 5 and 6). A relatively small part of the ground water is discharged by pumping.

TABLE 5.—*Daily mean discharge, in cubic feet per second, of Marlboro Brook, Maynard Ordnance Test Station, Massachusetts, for the period April 23, 1955, to June 30, 1956*

Day	1955									1956					
	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
1	----------	0.66	0.43	0.19	0.14	[1]0.75	[1]0.50	0.78	0.54	[1]0.31	0.52	0.52	0.69	1.10	0.88
2	----------	.60	.36	.26	.13	[1].68	[1].49	.68	.54	[1].31	.55	.56	.80	1.02	.75
3	----------	.56	.32	.30	.13	[1].64	[1].48	.61	.54	[1].31	.54	.70	.86	.98	.83
4	----------	.54	.31	.21	.13	[1].60	[1].47	.98	.66	[1].31	.52	.91	1.03	.95	.88
5	----------	.54	.30	.19	.12	[1].56	[1].46	2.21	.77	[1].30	.48	.81	1.51	.91	.73
6	----------	.57	.28	.22	.12	[1].54	[1].58	1.44	.61	[1].30	.47	.71	1.77	.90	.67
7	----------	.54	.29	.25	.15	[1].52	[1].80	1.12	.56	[1].30	.70	1.08	1.65	.88	.58
8	----------	.55	.28	.20	.15	[1].50	[1].60	.97	.52	[1].30	.61	1.12	1.40	.83	.52
9	----------	.52	.28	.18	.13	[1].48	[1].50	.88	.51	[1].30	.60	.91	1.39	.79	.52
10	----------	.47	.26	.20	.13	[1].46	[1].44	.83	.50	[1].31	.60	.79	1.50	.78	.52
11	----------	.46	.25	.19	.14	.45	[1].40	1.36	.47	[1].32	.59	.79	1.64	.78	.50
12	----------	.44	.62	.17	.19	[1].44	[1].36	1.10	.46	[1].36	.91	.78	1.64	.79	.47
13	----------	.42	.46	.17	.26	[1].43	[1].35	.91	.44	[1].41	.79	.78	1.59	.76	.58
14	----------	.42	.34	.16	.23	[1].43	[1].35	1.20	.42	[1].47	.71	.78	1.47	.75	.66
15	----------	.41	.29	.16	.16	[1].42	1.12	1.04	.42	[1].50	.74	.76	1.41	.73	.50
16	----------	.39	.26	.25	.15	[1].42	1.31	.95	.41	[1].53	.73	.73	1.75	.71	.72
17	----------	.38	.26	.21	.15	[1].41	1.44	.91	.41	[1].56	.66	.71	1.74	.68	.63
18	----------	.37	.23	.18	.72	[1].41	1.00	.84	.40	[1].58	.63	.68	1.44	.67	.50
19	----------	.36	.22	.18	7.04	[1].41	.81	.76	[1].39	[1].60	.60	.66	1.31	.66	.45
20	----------	.35	.25	.16	[1]2.50	[1].42	.71	.75	[1].38	[1].61	.57	.64	1.20	.63	.42
21	----------	.34	.35	.16	[1]1.50	[1].41	.67	.71	[1].36	.61	.56	.64	1.16	.61	.42
22	----------	.33	.40	.15	[1]1.05	[1].41	.63	.70	[1].35	.61	.53	.66	1.10	.58	.41
23	0.44	.33	.26	.15	[1]1.50	[1].40	.57	.67	[1].34	.61	.51	.72	1.17	.71	.38
24	.43	.32	.38	.17	[1]1.45	[1].58	.57	.64	[1].33	.60	.50	.71	1.14	.73	.36
25	.64	.31	.35	.16	[1]1.00	[1].70	.58	.64	.37	.58	.58	.66	1.02	.64	.32
26	.76	.31	.28	.15	.88	[1].55	.54	.63	.35	.56	.67	.61	.98	.63	.29
27	.76	.33	.24	.15	1.09	[1].48	.52	.61	.34	.54	.61	.60	.97	.74	.29
28	.61	.30	.23	.14	.93	[1].50	.50	.60	.33	.53	.66	.58	.96	.71	.29
29	1.04	.28	.22	.14	[1].80	[1].49	.50	.58	[1].32	.52	.57	.58	1.35	.66	.29
30	.81	.28	.20	.14	[1].75	[1].48	.50	.56	[1].32	.60	----------	.60	1.37	.63	.29
31	----------	.36	----------	.14	[1].80	----------	1.09	----------	[1].32	.58	----------	.61	----------	.82	----------
Total	5.49	13.04	9.20	5.68	24.62	14.97	19.84	26.66	13.68	14.33	17.71	22.39	39.01	23.76	15.65
Average	----------	0.42	0.31	0.18	0.79	0.50	0.64	0.89	0.44	0.46	0.50	0.72	1.30	0.77	0.52

[1] Estimated.

TABLE 6.—*Miscellaneous discharge measurements, in cubic feet per second, of unnamed tributary, about 2,000 feet north of Marlboro Brook gaging station, 1955*

Date	Discharge	Date	Discharge
April 29	0.20	August 15	0.07
May 9	.22	October 14	.12
June 17	.12	December 23	.21
July 19	.08		

All three of the major geologic units considered in this report contain some ground water. The water in all is generally hydraulically continuous, but the till and bedrock have such low permeability that movement of water through them or between them and the outwash is very slow. Nevertheless, there is, or can be, interchange of some water between these units where hydraulic gradients favor such movement. However, as has been discussed, water in the bedrock occurs only in limited quantities along fractures. The till is so compact and has such low permeability that water contained in it moves very slowly and cannot be pumped through wells in appreciable quantities. The outwash deposits are the most permeable, and also the most extensive deposits available for well development (pl. 1). Therefore, they constitute the principal aquifer and the water contained in them constitutes the principal ground-water body of this area.

PRINCIPAL AQUIFER

The relation between the principal aquifer and the other units is illustrated on plate 2. The sections are along lines *A–A′* and *B–B′* on plate 1. They show the till blanketing the bedrock, and the outwash resting on or against the till. The sections also show the water table in the fall of 1955. The water table is in the upper coarse-grained part of the principal aquifer in most places. The average thickness of the zone of saturation in the outwash is about 50 feet; the maximum is about 80 feet.

These sections indicate that the outwash, containing the principal ground-water body, is nearly continuous and uninterrupted across the area from west to east (from Boons Pond to about Dutton Road); but that it is partially restricted within the eastern part of MOTS (section *B–B′*) on the south by Hill 210 and on the north by Hill 235. Elsewhere, the body is continuous southward to the head of Hop Brook, and northeastward to the lowland that contains Bottomless Pond and Willis Pond. Beds of clay such as are reported in the Pine Lake area were not found within MOTS. However, a considerable thickness of very fine to fine sand and silt was penetrated in several test holes. Most of the beds of sand and gravel are in the upper

20 to 30 feet, except near well S111 (section *B–B′*, pl. 2), where almost all the outwash is coarse grained.

There appear to be no significant obstacles to the movement of ground water within the outwash except for a few bodies of till and clay and several high points on the bedrock surface which may distort the pattern of flow locally. The water occurs mostly under water-table conditions, but locally there may be some degree of confinement or retardation of the movement of the water owing to lenses of silt or layers of sand of different permeability. Silt, clay, and organic matter in the bottoms of some of the ponds and swamps also may retard the movement of ground water into or out of those bodies. However, in general, under natural conditions, the lakes and swamps actually or very nearly coincide with the top of the zone of saturation in most places and thus seem to be exposed parts of the water table.

The water table, as thus defined, is the top of the principal ground-water body, and till of low permeability forms the bottom. Two features of the water table are significant. One of these is its fluctuations in altitude; the other is its shape, which is indicative of the direction of movement of the water.

FLUCTUATIONS OF THE WATER TABLE

The water table rises and falls in response to changes in the balance between recharge and discharge. Changes in any one or a combination of these factors cause fluctuations of the water table in varying amount. These fluctuations, as indicated by the measurements of water levels in wells, ponds, and swamps during part of 1955 and 1956 and a few miscellaneous measurements made in earlier years, are given in tables 11 and 12. Plates 3 and 4 show some of the selected records graphically. The water table is in the outwash in most places but at a few it is in till and bedrock. The depth to the water table in the outwash generally is less than 15 feet, but at Pine Lake and in the area near Dutton Road to the southeast it is as deep as 20 to 30 feet below the land surface at several places. The water table in bedrock and in till generally is deeper than that in outwash, but the information is scanty. Therefore, the following discussion relates chiefly to the water table in the outwash.

As shown on plate 3, the range of water levels in wells from the low levels in 1955 to the high levels in the spring of 1956 was from about 2 to 5 feet. The low levels in the summer of 1955 would have been somewhat lower had it not been for hurricane rains in the middle of August, during which about 10 inches of rain fell within one day. A graph showing the fluctuations of the water table in a shallow well due to intermittent recharge from rainfall is given in figure 6. The

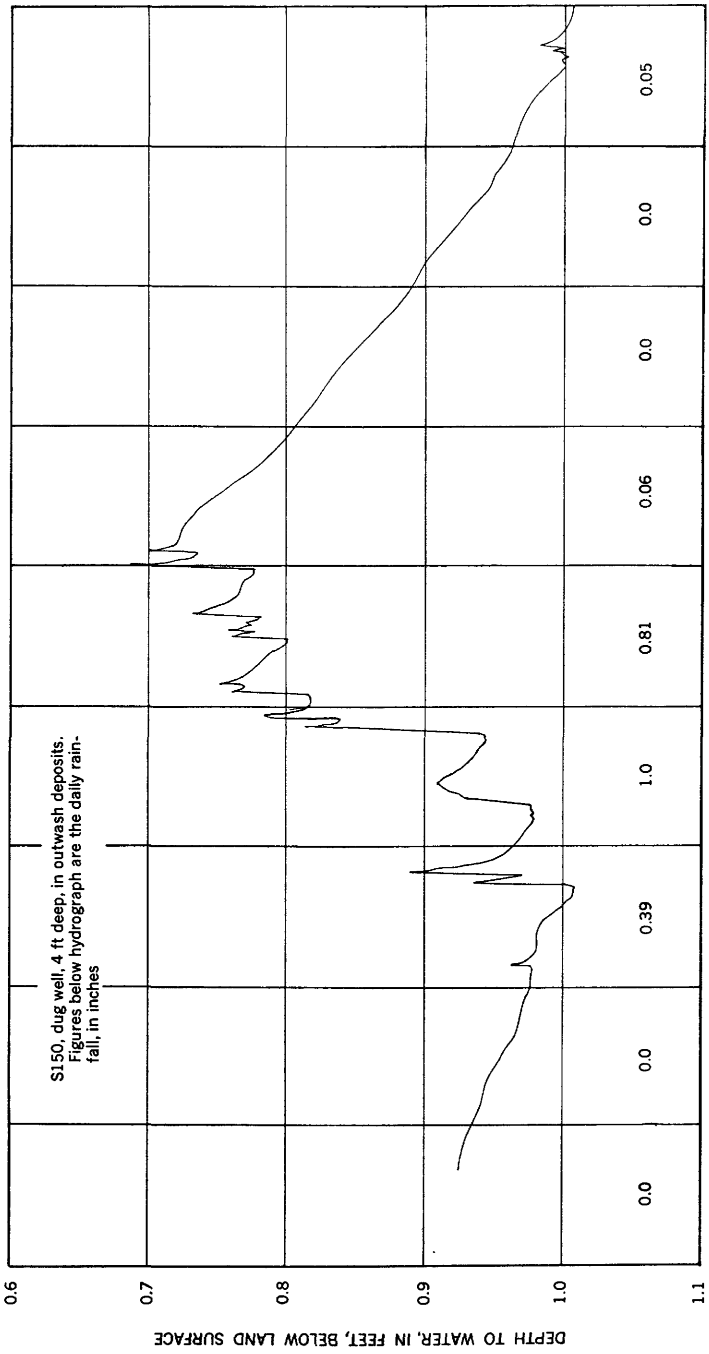

FIGURE 6.—Hydrograph showing the effect of intermittent rainfall of short duration on the shallow water table, Maynard Ordnance Test Station, Massachusetts, August 9–17, 1955.

well, S150, was 4 feet deep and was about 10 feet from a small water-table pond in the northwestern part of MOTS. The peak levels shown on the graph are of short duration, and most of them represent less than 0.1 foot of rise. The rise of the water table in response to the rainfall was nearly instantaneous, as the depth to water was less than a foot below the land surface and the deposits consist of permeable, coarse sand and gravel. The cumulative effect of the rainfall, which totaled about 2.3 inches during the period from August 11 to August 14, was an overall rise in the water table of about 0.3 foot.

Plate 4 shows hydrographs for selected ponds. In these the range of water levels was about 2 to 3 feet. However, several ponds actually were dry in July and August of 1955 before the hurricanes. The water levels in the ponds and wells fluctuate almost simultaneously, but the magnitudes are somewhat different for short periods. The small ponds have about the same range as the wells, but the large ponds such as Willis Pond and White Pond had a smaller response to the hurricanes in August. However, from the summer of 1955 to the spring of 1956 the large ponds rose about as much as the smaller ones. This similarity of fluctuations, in both magnitude and time, indicates that in general the ponds and swamps are all part of the principal ground-water body.

The fluctuations of water levels shown on all the hydrographs are due almost entirely to natural changes in the balance between recharge and discharge. The decline of water level at White Pond (pl. 4), however, is caused partly by pumping. White Pond is the source of supply for the town of Maynard. The drawdown and recovery of water levels in a pumped well and in nearby pairs of shallow and deep observation wells screened in outwash are discussed in the section dealing with the aquifer test (p. E32–E39).

Because the fluctuations are almost simultaneous everywhere, the general shape of the water table probably is very nearly the same at one time as another. However, at times of unusual drought, or of particularly heavy withdrawals from White Pond, it is conceivable that the configuration of the water table might change at some places. The full pond level for White Pond is reported to be 191.8 feet above mean sea level. In May 1951 the pond was about 0.5 foot above its full level. In January 1950, on the other hand, according to data from the Maynard's Water Department, the water level in White Pond was at a record low of about 187 feet above mean sea level. If such a lowering were induced largely by heavy withdrawals and therefore did not accompany corresponding declines of the water table everywhere else in the area, such a decline probably would

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shift the location of the main ground-water divide eastward. However, the low pond level in January 1950 probably was caused to a large extent by a marked deficiency in precipitation during 1949 (the total precipitation was only about 30 inches for the year) rather than by withdrawals from the pond, which were not above average during 1949. Thus it is likely that there was an overall regional lowering of the water table during 1949 and the early part of 1950 that was not accompained by a substantial change in its general shape.

MOVEMENT OF WATER

The contour lines drawn on plate 1 show the configuration and altitude of the water table. The contours are based on measurements of water levels made in wells, ponds, streams, and swamps, mainly during the last week of September and the first week of October 1955. Altitudes of the measuring points were determined by spirit leveling. The contour interval is 5 feet in most parts of the map—generally where the altitude of the water table is above 170 feet. Along Stearns Mill Pond and the lower reach of Hop Brook the water-table slopes are steeper, so the contour lines at 155 and 165 feet are omitted in these areas.

The shape of the water table correlates generally with the topography. That is, it is highest with respect to mean sea level beneath the hills and uplands, such as Hill 210 and the small uplands around the Pine Lake and Dutton Road areas, and lowest, but at least depth beneath the land surface, in the lowland areas along streams. Accordingly, the natural direction of ground-water movement is from higher altitudes on the water table beneath the upland areas to lower altitudes at streams and ponds where the water discharges. This discharge sustains the low flows of the streams in the area (tables 5 and 6).

Of particular significance with respect to the ground-water conditions are four important features illustrated by the contours on the water table.

First is the persistent, broad low ground-water divide in the Maynard Ordnance Test Station, generally in the area between Concord Road and the railroad-classification yard in the center of MOTS. At the end of September 1955 the water table along the divide in this area was at an altitude ranging from about 192 to 196 feet. The altitude of the water surface at White Pond was about 190 feet at the same time. Thus, there was a gradient toward White Pond and water was moving very slowly westward toward the pond from the divide. However, east of the classification yard, water normally moves eastward toward Marlboro Brook and other streams. A similar pattern of movement in the vertical dimension is illustrated schematically on plate 2*A* by the short arrows which represent the direction of flow. Thus it is apparent that water on the east side of the divide does not move toward White Pond under natural conditions, at least under the conditions portrayed on plates 1 and 2. However, the divide is so low and broad that changes in the discharge pattern, resulting particularly from artificial withdrawals, might make it shift substantially. In this connection, it is significant that at least during the period of this investigation (1955–56), the general shape of the water-table profile along section *A–A′* (pl. 2) was virtually unchanged during high as well as low water.

Second are the relatively steep gradients and the upstream bowing of the water-table contours close to Marlboro Brook and the unnamed brook to the north. These show that ground water is moving directly and relatively rapidly into those streams. Thus, in the area east of the 190-foot contour, between Hill 210 and Hill 235, any water that percolates deep enough to reach the water table under the conditions shown on plate 1 would ultimately discharge into one or the other of those streams, and would eventually reach Stearns Mill Pond and Hop Brook. The direction of movement of water in Hill 210 and Hill 235 probably is outward from the center of low water-table mounds beneath the hills. The data are scanty, however, and wells penetrating the saturated till are needed to map the water table accurately.

As shown by the hydrographs on plates 3 and 4 and the records given in tables 11 and 12, the altitude of the water table fluctuates seasonally within a range of at least a few feet. Changes in the configuration of the water table that accompany these seasonal fluctuations are not known in detail. The main ground-water divide may shift slightly in the area of low relief near and east of White Pond, but the overall shape of the water table and the pattern of movement, particularly near the east boundary of MOTS, probably would not change significantly. However, during times of high water table the rate of ground-water discharge into the brooks will be relatively great. For example, table 5, which gives the discharge of Marlboro Brook for the period from April 23, 1955, to June 30, 1956, shows that for the period represented by the water-table contour map (September 1955), the daily mean discharge was about 0.5 cfs. In April 1956, on the other hand, when the water table was at its seasonal high, the daily mean discharge of Marlboro Brook was 1.3 cfs. The maximum daily mean discharge of Marlboro Brook during the period of record was about 7 cfs on August 19, 1955, during a hurricane.

Third is the low east-west elongated ground-water mound beneath the Pine Lake area. This configuration suggests that the Pine Lake area is a center of local ground-water recharge. Movement of water is largely outward from the center of this area toward Willis Pond on the north, Bottomless Pond on the west, and Hop Brook and its tributaries on the south and southeast.

Fourth, in the southeastern part of the Maynard area there is another residential development which lies on the crest of a large ground-water mound whose axis roughly coincides with Dutton Road. Here most of the ground water moves northwestward through the outwash deposits toward Stearns Mill Pond on Hop Brook and southeastward beyond the report area.

The contour map of the water table shows the horizontal component of movement. Components of movement in the vertical direction are indicated by differences in water level measured in pairs of shallow and deep wells screened in the outwash. For example, at the site of well H7 (57 feet deep) and well H8 (11.6 feet deep) on Concord Road east of White Pond, the water level in the deep well averages about 0.14 foot lower than that in the shallow well, suggesting a small downward component of movement. An upward component is suggested by the data from well S118 (50 feet deep) and nearby well S119 (20 feet deep) on the southeast side of pond X-11 in east-central MOTS. Here the water level in the deep well is about 0.4 foot higher than that in the shallow well. At a pair of wells, S122 (20 feet deep) and S123 (40 feet deep), southwest of pond X-11, and at another pair of wells, S124 (20 feet deep) and S125 (35 feet deep), north of the pond, the difference in water level between the shallow and deep wells is only about 0.04 foot, suggesting nearly parallel movement of water in both the shallow and deep parts of the outwash in those areas. Short-term records for several of the pairs of shallow and deep wells show that under natural conditions the fluctuations of water levels in each pair correspond in time and in magnitude. This similarity is an indication of the hydraulic continuity of the water in the outwash.

AQUIFER TEST IN DEPOSITS OF GLACIAL OUTWASH

By N. J. Lusczynski

PURPOSE AND PROCEDURE

In September 1955 a detailed aquifer test was made to determine the yield and specific capacity of the MOTS supply well (S115), the extent of the cone of depression created by pumping the well, and the hydraulic characteristics of the outwash in the vicinity of the well.

The wells measured included the pumped well and 20 observation wells, all screened in the deposits of outwash. The zone of saturation is about 45 feet thick at the test site. The observation wells were 3 to 1,600 feet from the pumped well (pls. 1, 2; table 7). The screen of the supply well was 10 inches in diameter and 20 feet long and was set in the lower half of the zone of saturation from 37 to 57 feet below the land surface. Six deep observation wells also were screened in the lower part of the outwash at distances of 3, 43, 50, 100, 300, and 440 feet from the supply well. Four observation wells were screened in the upper part of the outwash about 20 to 25 feet above the screens of the deep observation wells at 50, 100, 300, and 440 feet from the supply well. Ten additional observation wells were screened in the uppermost part of the outwash. A staff gage and a recorder were installed in pond X–11, about 100 feet from the supply well.

The ground-water geology and hydrology, as discussed in previous sections of the report, indicate water-table conditions at the test site. During the aquifer test, the supply well was pumped by a deep-well turbine driven by a diesel engine for nearly 50 hours from 11:30 a.m. on September 22 to 1:16 p.m. on September 24, 1955. The pumped water was conducted in a 5-inch aluminum pipe about 1,000 feet northeast of the supply well and discharged on the land surface in the vicinity of an unnamed brook near well S145 (pl. 1). The pumping rate was practically constant throughout the test, as indicated by periodic readings of a flow meter installed on the discharge pipe near the supply well and also by periodic manometer readings made near the end of the discharge pipe. The flow meter recorded an average rate of 603 gpm.

Water-level readings were obtained manually or by recording instruments at the supply well, at the observation wells, and at the pond before, during, and after the pumping period. A summary of these readings and other pertinent data are given in table 7.

The water-level data in table 7 indicate the following:

1. A drawdown of 17.19 feet at the supply well after nearly 50 hours of pumping at 603 gpm, and thus a specific capacity of 32 gpm per foot of drawdown.
2. A decrease in drawdown in the upper part of the outwash from 6.56 feet at a distance of 7 feet from the pumped well to 0.34 foot at a distance of 440 feet, and about 0.09 foot at a distance of about 520 feet. It is inferred from these drawdowns that the cone of depression in the shallow deposits extended radially no more than about 600 feet from the pumped well.
3. A decrease in drawdown in the lower part of the outwash from 16.50 feet at a distance of 3 feet from the pumped well to 0.55 foot at a distance of 440 feet. This information and that noted above (2) suggest that the influence of the pumping probably extended a somewhat greater distance radially in the deeper beds than in the shallow beds; the maximum extent may have been as much as 700 feet from the pumped well.

TABLE 7.—*Summary of well and water-level data for aquifer test, September 22–26, 1955*

[Type of water-level measurement: M, wetted-tape method; R, water-stage recorder]

Well or pond No.	Distance from supply well (feet)	Approximate direction from supply well	Type of water-level measurement	Altitude of screen above mean sea level (feet)	Altitude of water level above mean sea level (feet)			Change in water level (feet)		Adjusted drawdown [4] (feet)
					Sept. 22 [1]	Sept. 24 [2]	Sept. 26 [3]	Cols. 7–6	Cols. 8–7	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
S115 (Supply well)			R	141.4–161.4	187.94	170.66	186.66	−17.28	+16.00	−17.19
Observation wells affected by pumping of supply well										
S116	3	NW.	M	144.4–154.4	187.95	171.36	186.65	−16.59	+15.29	−16.50
S111	7	NW.	M	180 –182.5	187.65	181.0	186.69	−6.65	+5.69	−6.56
S117	43	SE.	R	148.4–152.4	187.95	171.66	186.66	−16.29	+15.00	−16.20
S119	50	SW.	R	178.2–182.7	187.55	183.08	186.07	−4.47	+2.99	−4.38
S118	50	SW.	R	148.2–152.2	187.93	171.93	186.66	−16.10	+14.83	−16.01
S120	100	SW.	R	177.6–182.1	187.56	183.75	186.17	−3.81	+2.42	−3.72
S121	100	SW.	R	148.6–155.6	187.90	173.52	186.58	−14.38	+13.06	−14.29
S122	300	SW.	R	176.8–181.3	187.45	186.37	186.55	−1.08	+.18	−1.03
S123	300	SW.	R	156.8–160.8	187.41	185.91	186.51	−1.50	+.60	−1.45
S124	440	N.	R	177.0–181.5	190.16	189.73	189.74	−.43	+.01	−.34
S125	440	N.	R	157.0–161.0	190.13	189.49	189.70	−.64	+.21	−.55
S144	520	SE.	RM	180.3–182.3	186.03	185.89	185.73	−.14	−.16	−.09
Observation wells and pond not affected by pumping of supply well										
X-11	100	N.	RM		190.19	[5] 190.17	190.13	−0.02	−0.04	0
S113	900	SE.	M	165.2–167.7	183.74	183.67	183.57	−.07	−.10	0
S131	950	SW.	M	170.1–172.1	184.15	184.10	184.05	−.05	−.05	0
S126	965	W.	M	181.9–183.9	188.60	188.38	188.20	−.22	−.18	0
S127	1200	NNW.	M	186.8–188.8	192.81	192.72	192.63	−.09	−.09	0
S130	1400	SW.	M	173.5–175.5	178.48	[6] 178.45	178.44	−.03	−.01	0
S114	1600	NW.	M	171.2–174.7	193.17	193.09	193.01	−.08	−.08	0
Observation wells affected by infiltration of pumped water discharged on land surface										
S140	720	NE.	RM	182.2–184.2	186.51	[7] 187.15	186.66	+0.64	−0.49	0
S145	940	NE.	M	184.2–186.2	187.89	193.33	188.56	+5.44	−4.47	0

[1] Static water level at start of pumping.
[2] Water level after about 3,000 minutes of pumping at 603 gpm.
[3] Water level about 3,000 minutes after shutdown.
[4] Column 9 adjusted for natural trend of water levels and effect of infiltration of pumped water.
[5] Reflects 0.07-foot rise due to precipitation on September 24.
[6] Reflects 0.07-foot rise due to precipitation on September 24.
[7] Reflects 0.15-foot rise due to precipitation on September 24.

4. Differences in drawdown of 11.63 feet and 10.57 feet at pairs of wells screened in the shallow and deep parts of the outwash at distances of 50 and 100 feet from the pumped well.
5. Differences in drawdown of 0.42 foot and 0.21 foot at pairs of wells screened in the shallow and deep outwash at distances of 300 feet and 440 feet from the pumped well.
6. Observed recovery 50 hours after pumping was stopped was significantly less than the observed drawdown at the end of the pumping period at observation wells within a radius of 440 feet from the pumped well.

Most of the discharge from the pumped well ran off over the land surface into the unnamed brook near S145. Some of it infiltrated below the land surface and built up a local recharge mound on the water table. Of the water levels measured, only those in wells S145 and S140 showed the effects of this discharge of the pumped water on the land surface. At well S145, a few feet from the point of discharge, a rise of 5.44 feet was observed by the end of the pumping period and at well S140, about 200 feet from the point of discharge, a rise of 0.64 foot was observed. Thus, the slope of the water-table mound between these two wells indicates that the effects of the recharge spread about 400 feet radially from the end of the discharge line and apparently did not reach other observation wells or the pumped well.

During the test there was a natural decline of ground-water levels in the area. This is indicated by the downward trend of water levels at wells which were beyond the influence of pumping and which were not affected by recharge of the pumped water (table 7). In general, water levels declined naturally a maximum of about 0.09 foot during the drawdown period and approximately an additional 0.09 foot during the recovery period.

A total of 1.15 inches of rain fell during the last 11 hours of the pumping period and the first 3 hours of the recovery. The effect of the rainfall was detected only at wells S140 and S130, and at pond X-11. The water level rose 0.15 foot at S140 and 0.07 foot at S130 and pond X-11 by the end of the pumping period.

Changes in ground-water levels between the start and end of pumping were adjusted both for the natural decline of water levels and for the infiltration of the pumped water. The adjusted drawdowns (table 7) indicate the extent of the cone of depression around the pumped well.

ANALYSIS OF THE DATA

The coefficients of transmissibility and storage were determined by means of the nonequilibrium formula developed by Theis (1935) for two-dimensional (radial) flow. The coefficient of transmissibility is the rate of flow, at field temperature, in gallons per day, through a vertical strip of aquifer 1 foot wide and extending the full saturated height of the aquifer under a hydraulic gradient of 100 percent (decline of 1 foot in head for each foot of flow length). The coefficient of storage is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. For water-table conditions, the coefficient of storage is virtually the same as the specific yield of the material dewatered during pumping.

The Theis nonequilibrium formula is

$$s = \frac{114.6Q}{T} W(u)$$

in which s is the drawdown, in feet, at any point of observation in the vicinity of a well discharging at a constant rate;

Q is the discharge of a well, in gallons per minute;

T is the transmissibility, in gallons per day per foot;

$W(u)$ is the well function of u (equal to the exponential integral

$$\frac{e^{-u}du}{u};$$

u equals 1.87 r^2S/Tt;

r is the distance, in feet, from the discharging well to the point of observation;

S is the coefficient of storage, expressed as a decimel fraction;

and t is the time, in days, since the start of pumping.

The formula is based on the following assumptions: (a) the aquifer is homogeneous and isotropic (transmits water equally readily in all directions), (b) the aquifer is infinite in areal extent, (c) the pumped well penetrates and receives water from the entire thickness of the aquifer, (d) the coefficients of transmissibility and storage are constant at all times and places, (e) water removed from storage is discharged instantaneously with decline in head, (f) the flow is radial, and (g) the aquifer is not affected by recharge or by other discharge during the test.

The hydraulic coefficients computed for the outwash from selected test data are approximate, as the field conditions at the test site are only approximations of the ideal conditions assumed by the Theis formula.

Under the conditions at the test site, the principal source of water during the test was drainage from the upper part of the aquifer. Therefore, the movement of water was mostly from the shallow beds to the screen of the pumped well set in the deeper beds. Consequently, much of the flow was downward in the immediate vicinity of the supply well, and it could be assumed to be radial only in the outer part of the cone of depression.

The geologic description (p. E21–E24) indicates that the outwash at the site is anisotropic. This departure from isotropy prohibits the use in the Theis equation of drawdown determinations from that part of the aquifer where the flow is not virtually radial. The sections (pl. 2) show that the aquifer is not homogeneous and is less permeable with increasing distance from the pumped well, at least along sections *A–A′* and *B–B′*. This fact suggests that the transmissibility of the outwash is not constant and decreases with increasing distance from the pumped well.

It is generally known that instantaneous release of storage does not take place under water-table conditions, becasue water does not drain completely from the smaller pores in the dewatered portion of an aquifer at a rate that approaches instantaneous release. Too, the anisotropic character of the beds causes additional lag in the release of water from storage. This makes the Theis formula invalid at the time of incomplete drainage. However, the formula is applicable at the time of practically complete drainage even though the drainage may not have been instantaneous. Under water-table conditions, dewatering continues during the early part of the pumping period, and is believed to be nearly complete after about 2 to 4 days of pumping.

The departure between the assumed conditions of the Theis formula and the actual field conditions were thought to be least significant at wells S122 and S123 and at wells S124 and S125. At these pairs of wells, 300 and 440 feet, respectively, from the pumped well, the effect on the drawdown due to partial penetration of the pumped well was relatively small and the flow was considered radial. Also, the pumping period of nearly 50 hours was probably sufficient for nearly complete drainage of the dewatered zone in the upper part of the outwash.

Drawdowns in observation wells at and near the supply well and also those in wells S124 and S125 probably were influenced slightly by downward leakage from the nearby shallow pond. This leakage was probably not significant because the silt, clay, and organic matter along the bottom of the pond must have retarded appreciably the rate of movement of water from the pond to the underlying ground-water body. If this were not so, the drawdown at wells S124 and S125, located on the side of the pond, opposite the pumped well, would have been much less than that observed. Changes in the pond level observed during the drawdown period were very small and apparently were mostly natural.

The determination of the hydraulic coefficients was made by a graphical procedure which requires the matching of the curve for s

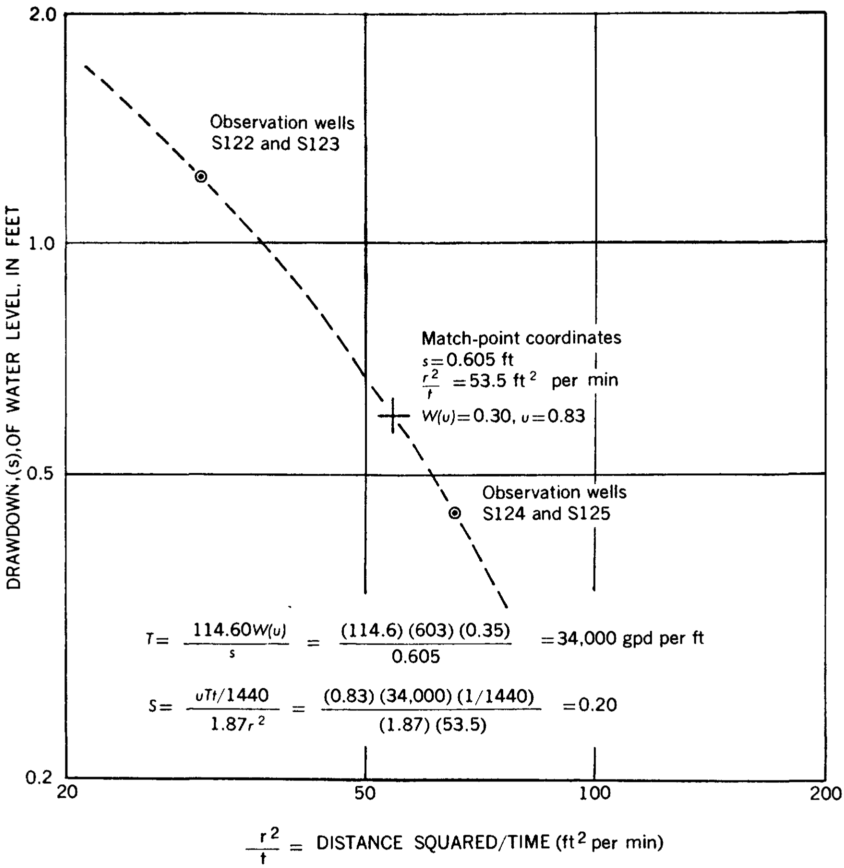

FIGURE 7.—Log-log plot of s versus r^2/t for pairs of wells 300 feet and 440 feet from the pumped well, at the end of 2,986 minutes of pumping at an average rate of 603 gpm.

versus r^2/t with the standard type curve of $W(u)$ versus u (fig. 7). The type curve is not shown on the illustration. The average of the adjusted drawdowns at each pair of wells 300 and 440 feet from the pumped well was used for the s value.

The coordinates of the selected match point (fig. 7) were used in the Theis formula to compute the coefficient of transmissibility and the specific yield. The computed transmissibility, 34,000 gpd per foot, represents an average for the material in the saturated zone within a 600-foot radius of the pumped well. The computed specific yield, 0.20, is thought to be slightly less than the true value because complete drainage of the unwatered part of the aquifer probably was not achieved.

The coefficient of transmissibility (T) is the product of the field coefficient of permeability (Pf) and the saturated thickness (m) in feet, of the aquifer tested. The field coefficient of permeability is the rate of flow of ground water, in gallons per day, through a cross-sectional area of 1 square foot per foot at field temperature, under a hydraulic gradient of 100 percent. The saturated thickness of the outwash at the test site averages about 45 feet. Thus from the relation $T=P_f m$ the field coefficient of permeability was computed to be about 800 gpd per square foot.

In summary, the test showed (a) that the supply well could be pumped at 603 gpm with a specific capacity of 32 gpm per foot of drawdown after nearly 50 hours of pumping, (b) that the cone of depression (defined by actual dewatering of the outwash) extended about 600 feet from the pumped well, and (c) that the coefficients of transmissibility, permeability, and storage were about 34,000 gpd per foot, 800 gpd per square foot, and 0.20, respectively. The relatively high coefficient of storage confirms the existence of water-table conditions in the outwash.

CHEMICAL QUALITY AND TEMPERATURE OF THE GROUND WATER AND SURFACE WATER

Comprehensive chemical and radiochemical analyses of representative samples of water from three wells tapping the outwash deposits and one well tapping bedrock, and one sample each from White Pond and Marlboro Brook, are given in table 8. The analyses were made by the Quality of Water laboratory of the U.S. Geological Survey at Washington, D.C.

All the water analyzed was soft, and had a hardness ranging from 10 to 58 ppm. Except for that of water from the well tapping bedrock (S38), the pH values were 7.0 or less. The concentrations of most of the chemical constituents in all the samples are within the limits recommended by the U.S. Public Health Service (1946) for drinking water. However, in certain samples the concentration of a few constituents was substantially above the average. For example, at well S34 the above average concentration of nitrate (2.4 ppm), dissolved solids (119 ppm), and chloride (9.5 ppm) suggests slight contamination, probably from domestic wastes. The concentration of iron and manganese together (1.05 ppm) in water from the MOTS supply well (S115) is more than three times as high as the generally accepted standard of 0.3 ppm.

The water in the bedrock well (S38) differs from the other waters mainly in its relatively high pH (7.9) and bicarbonate content (83 ppm). Among the samples analyzed, the two samples of surface water had the lowest pH (5.7 and 5.9), the lowest hardness (7 and 10 ppm), and the lowest dissolved solids (21 and 23 ppm). The natural radioactivity of all the waters is low. The water from the MOTS supply well (S115) was the lowest of all the waters in beta-gamma activity and radium concentration.

TABLE 8.—*Typical chemical and radiochemical analyses of ground water and surface water, Maynard area, Massachusetts*

[Chemical constitutents in parts per million; specific conductance in micromhos at 25 ° C; beta-gamma activity in micromicrocuries per liter; radium in micromicrocuries per liter; and uranium in micrograms per liter. All analyses by U.S. Geological Survey]

Well No. or source	Location: Symbol	Location: Street and area	Owner	Depth (feet)	Geologic unit	Date of collection	Silica (SiO_2)	Aluminum (Al)	Iron (Fe) (total)	Maganese (Mn)	Copper (Cu)
S34	S/12-8g	Summer St., Sudbury	William Kelly	20	Outwash	Apr. 30, 1953	7.1	0.2	0.33	0.02	0.00
S38	S/12-8g	Pratts Mill Rd., Sudbury	Karl Borg	129	Bedrock	do	13	.0	.14	.09	.00
S115	S/12-7j	Maynard Ordnance Test Station, Sudbury.	U.S. Army	57	Outwash	Apr. 24, 1955	16	.0	.81	.24	.00
Sudbury well field (S148)	S/11-2c	Near Hop Brook, Sudbury	Town of Sudbury	34–62	do	Apr. 30, 1953	11	.0	.09	.00	.00
Marlboro Brook	S/12-7j	East of culvert, Marlboro Rd., Sudbury.				do	4.2	.2	.27	.00	.02
White Pond	S/12-7e	Near pump station, Hudson Rd., Stow	Town of Maynard			do	1.4	.0	.33	.00	.01

Well No. or source	Zinc (Zn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Lithium (Li)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Dissolved solids	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Specific conductance	pH	Color	Beta-gamma activity of residue	Radium (Ra)	Uranium (U)
S34	1.4	21	0.4	17	2.3	0.4	24	0	45	9.5	0.1	2.4	0.0	119	58	20	150	6.7	3	<50	0.43	------
S38	.26	18	2.9	11	2.0	.3	83	0	17	1.6	.3	.0	.2	108	57	0	165	7.9	2	<50	.56	------
S115	.00	4.5	1.1	3.2	.6	.0	26	0	.2	2.0	.1	.4	.1	52	17	0	49.9	7.0	6	<10	.3	<0.1
Sudbury well field (S148)	.17	12	2.1	5.7	.9	.2	32	0	12	12	.0	.4	.0	72	39	12	115	6.9	3	<50	.64	------
Marlboro Brook	.00	2.2	.4	2.3	.3	.1	6	0	5.2	2.2	.2	.1	.0	21	7	2	29.2	5.7	23	<50	.91	------
White Pond	.06	2.8	.7	2.7	.4	.1	6	0	9.6	2.4	.0	.0	.0	23	10	5	37.5	5.9	7	<50	.54	------

The temperature of water at eight wells ranged from about 48° to 58°F and averaged about 52°F. The water temperature at well S116, an observation well located within 10 feet of the MOTS supply well (S115) and screened at about the same depth, was 49°F on July 27, 1955. The temperature of water at the supply well was 48.5°F on September 30, 1955. No periodic measurements were made, but it is probable that the water in the shallow beds of outwash has a greater seasonal range in temperature than does the water in the deeper beds.

The temperature of surface water ranges widely during the year, in contrast to that of ground water. A few miscellaneous temperature readings were taken at White Pond from May through July 1955. The temperature ranged from 70° to 82°F and increased directly with the increase in average air temperature. In other surface-water bodies, temperature readings taken during the spring and summer of 1955 ranged from 53° to 92°F. All the surface-water temperatures were measured near the edge of the water bodies and close to the surface; therefore they probably are not an index of the temperature in the deeper portions.

UTILIZATION

During 1955 the peak daily withdrawal of ground water (including water pumped from wells and a ground-water pond) for public-supply, domestic, agricultural, and industrial use within the area of this investigation (pl. 1), was estimated to be about 612,000 gallons. Of this amount, about 79,000 gpd was withdrawn from wells and the remainder was pumped from White Pond, a water-table pond. The year-round withdrawals are somewhat less.

It is estimated that there are about 300 domestic wells in the area. Records for about 150 were collected and are given in table 9. On the basis of an assumed per capita withdrawal of 60 gpd and 4 persons per family unit, average withdrawals from the domestic wells are estimated as 72,000 gpd during the summer months. The pumping is concentrated mainly at Boons Pond, a summer resort; at Pine Lake, a combined year-round and summer resort; and in the area of small homes along Dutton and Pratts Mill Roads southeast of MOTS. Only two wells (S52 and S107) in MOTS were pumped in 1955 to supply small quantities of water for domestic use.

About 6,500 gpd was pumped from a small number of wells for agricultural purposes, mainly horticulture and hog and poultry farming. At the only industrial installation in the area, Sudbury Laboratories, it was reported that about 1,000 gpd was pumped from wells for use in the manufacture of soil-test kits.

The largest withdrawals of water in 1955 were made from White Pond, the nearest public-supply installation to MOTS. In May the withdrawal averaged about 360,500 gpd and in July, about 530,000 gpd. The peak daily withdrawal from White Pond was 646,000 gallons, in July 1952. The average daily withdrawal varies slightly from year to year. Since 1951 it has ranged from about 420,000 to 450,000 gallons. The water is used to supply the town of Maynard and part of MOTS.

One other public-supply installation not far from the report area is the well field (S148, table 2) owned by the town of Sudbury in the valley of Hop Brook about a mile beyond the southeast corner of the area of plate 1. The installation consists of a group of shallow well points screened in deposits of outwash. In 1952 an average of about 63,400 gpd was pumped from these wells.

Other ponds and streams within the area shown on plate 1 are not known to be used as a source of water for drinking. They are used mainly for boating, swimming, and some fishing. One large tract of swamp, west of Concord Road, in the southwest corner of the area, is used for growing cranberries commercially.

There is little doubt that substantial additional supplies of ground water can be developed in this area. Probably at least half the annual rainfall of about 42 inches percolates into the highly permeable outwash. This is equivalent to an average recharge rate of about a million gallons per day per square mile. In the areas where till and bedrock crop out extensively, the recharge would be much less. The results of the aquifer test suggest that well S115 at MOTS can be pumped intermittently at a rate of 500 to 600 gallons per minute without interfering with the White Pond supply, especially if most of the water is returned to the ground through recharge pits and wells.

CONCLUSIONS

Deposits of glacial outwash overlie till-covered crystalline bedrock in most of the Maynard area. In a few places the bedrock and isolated hills composed of till rise above the surrounding outwash plain. The outwash deposits are from 0 to about 100 feet thick and in general consist of two principal types: fine to coarse sand and gravel composing most of the upper part of the outwash, and silt and very fine sand composing most of the lower part. The first type is the source of water for most domestic wells. The second type contains water but does not yield it readily to wells. In at least one place, however, a narrow body of coarse sand and gravel, possibly representing a channel filling, occurs in the lower part of the outwash. The screen of well S115 at the Maynard Ordnance Test Station is set in this body of coarse-textured channel fill.

The outwash deposits contain and yield the largest supplies of ground water. In 1955 the pumpage averaged slightly more than half a million gallons a day and came mainly from White Pond. This pumpage is only a small part of the average daily recharge from precipitation on the report area.

For greatest efficiency, new wells of large yield should be spaced so as not to interfere substantially with existing supplies and should be screened in the thickest and most permeable parts of the outwash to allow for greater drawdown of the water level at higher rates of pumping. In most places, however, the water will have to be withdrawn from the upper permeable beds of outwash which are relatively thin. Moderate withdrawals from this zone probably could be made either through a large number of individual small-capacity wells spread over a large area or possibly through construction of gangs of small-diameter wells each connected to a common suction line. Construction of these installations near a stream or large lake hydraulically connected with the outwash would improve the prospects of relatively high sustained yields.

In a few places moderately high yields can be obtained from coarse-textured channel fill, such as the material tapped by well S115 which yielded 600 gpm with a drawdown of about 17 feet after 50 hours of pumping. The transmissibility, permeability, and storage coefficient of the outwash in the vicinity of well S115, as determined from an aquifer test, were about 34,000 gpd per foot, about 800 gpd per square foot, and about 0.20, respectively.

Deposits of till and the bedrock yield small quantities of ground water to individual wells for domestic supplies. The quality of the ground water generally is good. The water is soft but in some places may contain an excessive amount of iron.

Systematic exploration of the glacial deposits by means of test drilling and seismic surveys such as those made in the Maynard area probably would demonstrate the availability of substantial quantities of ground water in similar deposits in other parts of central and northeastern Massachusetts.

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BASIC DATA

TABLE 9.—*Records of wells and test*

Well No.: Capital letter preceding number is abbreviation of town name, S (Sudbury); St (Stow); and H (Hudson). Wells are numbered serially in each town. Former designations are indicated in the Remarks column.
Location: Letter and number symbols give the location of well with respect to the grid system described on pages E4–E5. MOTS, Maynard Ordnance Test Station; BMRR, Boston and Maine Railroad.
Altitude of land surface: Datum is mean sea level (msl) according to 1929 adjustment. Where estimated from topographic map, altitude is given to the nearest 5 feet; where based wholly or mainly on spirit leveling, altitude is given to the nearest tenth of a foot.
Type of well: Dg, dug; Dn, driven; DgDn, dug and driven; Dr, drilled; J, jetted; W, wash boring.
Depth of well: Reported depths are given in whole feet below land surface; measured depths are given in feet and tenths of a foot below measuring point (M.P.).

Well	Location		Owner	Altitude of land surface (feet)	Well			Water-bearing material
	Symbol	Street and (or) area			Type	Depth (feet)	Diameter (in.)	Character
								Town of
H1	S/12 −7h	400 ft east of Concord Rd.; 340 ft north of BMRR, MOTS.	U.S. Army	195	Dr	149(?)	8	?
H2	S/12 −7h	do	do	195	Dr	73	6	?
H3	S/12 −7h	White Pond Rd	James Green	198	Dn	19	1¼	Sand
H4	S/12 −7g	Concord Rd., south of BMRR.	Mr. Brigham	185	Dg	4±	12	do
H5	S/12 −7g	Parmenter Rd., 200 ft south of BMRR.	A. Ordway	209	Dg	16	24	do
H6	S/12 −7g	Parmenter Rd., 2,000 ft south of BMRR.	N. Gardner	240±	Dr	95	8	Granite-gneiss.
H7	S/12 −7e	Concord Rd., 700 ft south of Diagonal Rd., MOTS.	U.S. Army	202.7	Dn	56.9	1¼	Sand and gravel.
H8	S/12 −7e	do	do	202.7	Dn	11.6	1¼	do
H9	S/12 -7e	Fire La., 400 ft west of Concord Rd.	do	197.0	Dn	8.5	1½	do
H10	S/12 -7h	Fire La. near White Pond.	do	196.9	Dn	8	1¼	Coarse sand.
H11	S/12 -7h	Firehouse Rd., MOTS	do	197.4	Dn	11	1¼	Sand and gravel.
H12	S/12 -7h	Fire La., 400 ft east of Concord Rd., MOTS.	do	195.6	Dn	11	1¼	do
H13	S/12 -7h	150 ft west of Marlboro Rd., and BMRR.	do	197.8	Dn	8.5	1½	Medium-coarse sand.
H14	S/12 -7e	Near trail, southwest side of White Pond.	do	202.4	Dn	16.4	1¼	Sand
H15	S/12 -7h	Concord Rd., near Firehouse Rd., MOTS.	do	193	Dn, J	36		Fine sand.
H16	S/12 -7h	West side of Concord Rd. about 70 ft south of BMRR.	H. Bosworth	200	Dr	53	6	Schist

borings, Maynard area, Massachusetts

M.P.: Abbreviation of term measuring point. A fixed reference point generally at or near top of well casing from which water level or depth measurements are made.
Depth to water and altitude of water level: Reported levels are given in whole feet; measured levels are given in feet and tenths and hundredths of a foot.
Use of water: Dom, domestic; Ind, industrial; Irr, irrigation; S, stock; T, test well or test boring; Obs, observation well; U, unused.
Remarks: Yields of wells are given in gallons per minute (gpm); estimated use is given in gallons per day (gpd). Other data available indicated by: C, chemical analysis (table 8); H, hydrograph (pls. 3 and 4); L, log (table 10); W, record of water level fluctuations (table 11).

Water-bearing material—Continued	Ground-water level					Use	Other data and remarks
Geologic unit	Description of M.P.	Altitude of M.P. (feet)	Depth to water below MP (feet)	Altitude of water level (feet)	Date of measurement		
Hudson							
Bedrock and outwash(?).	Red arrow on wooden plank.	198.22	9.11	189.11	Sept. 26. 1955	U	Driller reported rock at 71 ft. Sounded depth in January 1956, about 149 ft. Casing, open end, depth to bottom unknown. (H).
Outwash(?)						U	Depth, uncertain Well sealed. H1, nearby.
Outwash	Top of casing	200.89	10.80	190.09	Oct. 2, 1955	S	Pumpage, about 400 gpd. Temperature of water, 51.5° F.
do	do	187.38	2.75	184.63	Aug. 26, 1955	U	
do	do		1.5		do	S	Supplies 1,800 chickens. M.P. is 4.5 ft below land surface.
Bedrock	do		30		October 1953	Dom	Pumping level, 95 ft. Dug well nearby, depth to water 0.8 ft, Aug. 26, 1955.
Outwash	do	207.80	14.98	192.82	Sept. 26, 1955	Obs	Test boring FD-6. Rock at 72 ft. (L), (H).
do	do	204.50	10.63	193.87	Nov. 30, 1955	Obs	About 13 ft south of H7. (H), (W).
do	do	200.01	8.29	191.72	Sept. 26, 1955	Obs	Well C.
do	do	200.53	10.00	190.53	do	Obs	Well D. (W).
do	do	200.32	9.54	190.78	do	Obs	Well E.
do	do	199.03	7.04	191.99	do	Obs	Well F.
do	do	200.70	8.16	192.54	do	Obs	Well G.
do	do	204.40	14.20	190.20	Oct. 2, 1955	Obs	Well F-F′.
do						T	Test Boring BH-1. (L).
Bedrock						Dom	Rock reported at 8 ft depth to water, 15 ft yield about 7 gpm.

TABLE 9.—*Records of wells and test borings*

Well	Location: Symbol	Location: Street and (or) area	Owner	Altitude of land surface (feet)	Well: Type	Well: Depth (feet)	Well: Diameter (in.)	Water-bearing material: Character
Town of								
S1	S/12-8g	Marlboro Rd., Sudbury	Paul Heikkila.	163.3	Dg	6.1	24–36	Sand
S2	S/12-8g	do	Mr. Nealand	168.2	Dg	17.0	36	do
S3	S/12-8d	do	Alton Clark	180	Dn	30	1½	do
S4	S/12-8d	Dutton Rd., Sudbury	Sudbury Laboratory.	177	Dg	13.7	30	do
S5	S/12-8d	do	do	175	Dn	14	1½	do
S9	S/12-8g	Marlboro Rd., Sudbury	Francis Raynor.	175	Dg	8.8	36	do
S10	S/12-8g	Dutton Rd., Sudbury	William M. Stearns.	165	Dn	17	1½	do
S12	S/12-8g	do	Carl Morrison.	187.0	Dg	26.3	30–36	do
S13	S/12-8g	Dutton Rd., Sudbury	L. H. Witeneck	156	Dg	7	30	do
S15	S/12-8g	do	Francis J. Dugan	175	J	16	2	Sand and gravel.
S16	S/12-8g	do	John Ferolito	180	Dg	16.3	30	do
S19	S/12-8g	do	Mr. Newton	180	Dg	13.8	36	do
S21	S/12-8g	Poplar St., Sudbury	John Enas	180	Dn	5	1½	do
S22	S/12-8g	Dutton Rd., Sudbury	Kenneth Grierson.	189.92	Dg	25.8	36	do
S25	S/12-8d	Hudson Rd., Sudbury	John Raynor	180	Dg	18	36	do
S27	S/12-8d	Birchwood Ave., Pine Lake.	J. Boyd	207	Dg	32	36	do
S28	S/12-8d	Oakwood Ave., Pine Lake.	John T. Cox	207.7	DgDn	32	12–1¼	do
S29	S/12-8d	Basswood Ave., Pine Lake.	Mr. Lindenfels	205.7	Dg	25	36	do
S30	S/12-8g	Dutton Rd., Sudbury	H. Whiteneck	181.8	Dg	11.4	30	do
S31	S/12-8g	Spring St., Sudbury	Edgar Lirette	180	Dn	20	1½	do
S32	S/12-8g	do	Mrs. L. Phelps	180	Dn	18	1½	do
S33	S/12-8g	Summer St., Sudbury	Mr. McAnulty.	182.7	Dg	15.9	30	do
S34	S/12-8g	do	William Kelly	187.3	Dg	20.4	30	do
S35	S/12-8g	do	John Martin	180	Dg	140	24–36	do
S37	S/12-8g	do	E. Cunningham.	180	Dn	15	1½	do
S38	S/12-8g	Pratts Mill Rd., Sudbury.	Karl Borg	190	Dr	129	6	
S39	S/12-8g	Dutton Rd., Sudbury	John R. Martin.	184	Dg	25.1	2.6	Sand
S40	S/12-8g	do	Joseph Bisson	180	Dg	19.9	2.6	do
S41	S/12-8g	Pine St., Sudbury	Lubin Doucette.	180	Dg			do
S42	S/12-8g	do	Mr. Walker	188.6	Dg	20.3	30	do

Maynard area, Massachusetts—Continued

Water-bearing material—Continued	Ground-water level					Use	Other data and remarks
Geologic unit	Description of M.P.	Altitude of M.P. (feet)	Depth to water below MP (feet)	Altitude of water level (feet)	Date of measurement		
Sudbury							
Outwash	Top of metal cover flange.	163.32	3.89	159.43	June 13, 1955	Dom	Estimated water level on Oct. 1, 1955, about 159 ft.
do	do	168.74	5.04	163.70	Oct. 1, 1955	Dom	Pump capacity 30 gpm.
do						Dom	Water level cannot be measured.
do	Floor of well house.	173.72	8.98	164.74	Oct. 5, 1955	U	Rock reported at depth of about 35 ft.
do	Cellar floor		6		Apr. 15, 1953	Dom Ind	Three other wells within 4 ft of each other. Pumpage, about 1,000 gpd.
do	Top of tile casing.	166.90	4.65	162.2	Mar. 10, 1955	Dom	
do	Top of casing		15		July 1952	Dom	
do	Top of cement casing.	187.30	19.97	167.33	Oct. 1, 1955	Dom	
do	Hole in wooden cover.	159.72	3.22	156.50	Oct. 1, 1955	U	
do						Dom	Yields at least 15 gpm.
do	Top of casing		9.1		Apr. 16, 1953	Dom	
do	Top of cement casing.		4.54		do	Dom	M.P. about 6 ft below land surface.
do	Cellar floor					Dom	Supplies 6 people.
do	Top of cement casing.	190.42	18.36	172.06	Oct. 1, 1955	Dom	Supplies 4 people.
do	do		5		Mar. 18, 1953	Dom Irr	Pumpage, about 6,000 gpd. M.P. about 5 ft below land surface.
do	do	207.47	23.73	183.74	Oct. 1, 1955	Dom	Water contains high concentration of iron.
do	Top of tile casing.	203.69	16.58	187.11	do	Dom	
do	Top of cement casing.	207.93	24.23	183.70	do	Dom	
do	Hole in concrete cover.	177.52	6.20	171.32	do	Dom	
do						Dom S	Supplies 5 people and 20 chickens.
do						Dom	
do	Top of cement casing.	184.06	9.69	174.37	Oct. 1, 1955	Dom	
do	do	188.15	13.62	174.53	do	Dom	(C).
do	do		5.00		Mar. 15, 1955	Dom	Well in use 24 years.
do						Dom	Water reported hard.
Bedrock						Dom	Rock at 92 ft. (C).
Outwash	Top of cement casing.		17.08		Mar. 10, 1955	Dom	Top of casing, 4.8 ft below land surface.
do	do		12.81		do	Dom	Top of casing, 5.4 ft below land surface.
do	do		18		Apr. 17, 1953	Dom	
do	do	189.66	15.49	174.17	Oct. 1, 1955	Dom	

TABLE 9.—*Records of wells and test borings,*

Well	Location: Symbol	Location: Street and (or) area	Owner	Altitude of land surface (feet)	Well: Type	Well: Depth (feet)	Well: Diameter (in.)	Water-bearing material: Character
								Town of
S43	S/12-8g	Dutton Rd., Sudbury	Thomas Beazley.	180	Dg	22	24	Sand
S44	S/12-8g	do	Mr. Kendall	180	Dn		1½	do
S45	S/12-8d	Hudson Rd., Pine Lake	F. W. Kelly	197.8	Dg	26	27	do
S46	S/12 8-d	do	Harry Dexter	200	Dn	20		do
S47	S/12-8d	Willis Lake Dr., Pine Lake.	Harry Scholsberg.	200	Dn	26	1¼	do
S48	S/12-8d	Pine Wood Rd., Pine Lake.	E. H. Staal	200	Dg	28	30	do
S49	S/12-8d	Willis Lake Dr., Pine Lake.	do	200	Dn	35		do
S50	S/12-8d	do	John J. Rowen	202	Dg	21.6	24	do
S51	S/12-8d	Priest Rd., Pine Lake	E. Ryan	200	Dn	38	2	do
S52	S/12-7f	Hudson Rd., MOTS	U. S. Army	204.1	Dg	14.8	24	do
S53	S/12-8d	Willis Lake Dr., Pine Lake.	Harold M. Hatch.	218	DgDn	35	36-1¼	do
S54	S/12-8d	Birchwood Ave., Pine Lake.	C. T. Kirkpatrick.	207	Dg	40	36	do
S56	S/12-7f	Basswood Ave., Pine Lake.	Mr. Caddigan	197	Dg	21.3	30	do
S57	S/12-7f	Crystal Lake, Pine Lake	Thomas A. Meaney.	190	DgDn	30	30-1½	do
S58	S/12-7f	Lakewood Dr., Pine Lake.	Daniel Devlin.	200	DgDn	30	30-1½	do
S59	S/12-7f	do	Fred C. Poor	200	Dn	20	1½	do
S60	S/12-8d	Hudson Rd., Pine Lake	John Raynor	199.7	Dg	23.6	36	do
S61	S/12-7f	do	F. Lehr	195	Dn	15	4-2	do
S62	S/12-8d	do	Michael Fleming.	195	Dg	22.0	36-30	do
S63	S/12-8d	do	Hector Marquis.	200	Dn	28	28-2	do
S64	S/12-8d	Birchwood Dr., Pine Lake.	J. F. Watts	200	Dr	100	6	do
S65	S/12-8e	Hudson Rd., Pine Rest	William Dudley.	170	Dr	310	8	Rock
S68	S/12-8d	Butler Rd., Pine Lake	Rosaro Caia	201.1	Dg	21	2½	Sand
S69	S/12-8d	Butler Rd., Pine Lake	Ethel Johnston.	200	Dn	35		do
S74	S/12-8d	Arborwood Rd., Pine Lake.	Robert Dunn	215	Dn			do
S75	S/12-8d	do	Gunhild Roos.	240	Dn	50		do
S76	S/12-8d	Elmwood Rd., Pine Lake.	John Martin	190	Dg	16	30	do

Maynard area, Massachusetts—Continued

Water-bearing material—Continued	Ground-water level					Use	Other data and remarks
Geologic unit	Description of M.P.	Altitude of M.P. (feet)	Depth to water below MP (feet)	Altitude of water level (feet)	Date of measurement		
Sudbury—Continued							
Outwash	Top of cement casing.		16		April 1953	Dom	
do						Dom	
do	Top of brick casing.	198.82	19.24	179.58	Oct. 1, 1955	Dom	
do						Dom	Supplies 10 people.
do						Dom	Supplies 5 people.
do	Top of cement casing.		17		April 1953	Dom	Top of casing, 5½ ft below land surface.
do						Dom	Supplies 7 people.
do	Top of tile casing.		15.26		Mar. 15, 1955	Dom	Top of casing, 4 ft below land surface. (L).
do						Dom	Layer of clay reported at 15 ft.
do	Inner lip of tile casing.	204.49	8.37	196.59	Sept. 26, 1955	Dom	Altitude of former M.P. used prior to Sept. 30, 1955, 204.96 ft. (H).
do	Wooden cover		32		1950	Dom	
do	Top of cement casing.		24		April 1953	Dom	
do	do	197.81	13.07	184.74	Oct. 1, 1955	Dom	
do	Cellar floor		Flowing		April 1953	Dom	Thin clay layer at about 5 ft.
do	Top of cement casing.		10.72		July 8, 1955	Dom	Top of casing, 6.75 ft below land surface. Temperature of water, 58° F.
do	Cellar floor		17		April 1953	Dom	Top of casing, 5.5 ft below land surface.
do	Top of concrete casing.	194.75	16.20	178.55	June 13, 1955	U	
do	Cellar floor		3		April 1953	Dom	Yield, 8 gpm.
do	Top of brick casing.	195.89	15.80	180.09	Oct. 1, 1955	U	Shallow well point, same property.
do						Dom	
do	Land surface		23		April 1953	Dom	Owner reports well did not penetrate bedrock. Dug well, same property.
Bedrock						Dom	Rock reported at 78 ft.
Outwash	Top of wooden shelf.	203.28	18.14	185.14	Oct. 1, 1955	Dom S	Rock reported at about 98 ft. Point well, same property, 24 ft deep.
do						Dom	
do						Dom	Supplies 5 people.
do						Dom	Supplies 4 people.
do	Top of cement casing.		9		April 1953	Dom	Temperature of water, 58° F.

TABLE 9.—*Records of wells and test borings,*

Well	Location: Symbol	Location: Street and (or) area	Owner	Altitude of land surface (feet)	Well: Type	Well: Depth (feet)	Well: Diameter (in.)	Water-bearing material: Character
								Town of
S78	S/12-8d	Lakewood Dr., Pine Lake.	R. MacInnis	190	Dg	19	29	Sand
S80	S/12-8d	do	C. B. Cummings.	190	Dg	27	30	
S81	S/12-7f	do	Sumner Whittemore.	192	Dg	19.2	30	Sand
S82	S/12-7f	Beechwood Dr., Pine Lake.	Andrew Repote.	190	Dn		1¼	
S83	S/12-8d	Hudson Rd., Pine Lake	Ernest Ferguson.	200	Dg	21.4	36–30	Sand
S84	S/12-8d	Pinewood Rd., Pine Lake.	John B. Dowse.	200	Dn	28	1½	do
S86	S/12-8d	do	Mrs. Chalk	200	Dg	30	30	do
S88	S/12-8d	do	Fred Hill	200	Dn	22	1¼	do
S89	S/12-8d	Gr. Lake Dr., Pine Lake.	Paul Anderson.	200	Dn	27	1¼	do
S90	S/12-8d	Basswood Ave., Pine Lake.	Louis Yered	205	Dg	19.4	30	do
S92	S/12-8d	do	Robert S. Stevens.	205	Dg	26.8	30	do
S93	S/12-8d	Basswood Ave., Pine Lake.	George Cyr	206	Dg	22.6	30	do
S94	S/12-7f	Beechwood Dr., Pine Lake.	William Delaney.	192	DgDn	17.9	39–1½	do
S96	S/12-7f	do	Orin Delaney.	200.0	Dg	13.6	12	do
S98	S/12-7f	HudsonRd., Pine Lake	Fred Lehr	192.8	Dg	7.9	36	do
S99	S/12-7f	do	do	194	Dg	8.9	36	do
S100	S/12-8d	Priest Rd., Pine Lake	A. Bakinowski.	208.3	Dn	25	1¼	do
S101	S/12-8e	Hudson Rd., Pine Rest	S. Floridia	191	Dg	18	30	do
S102	S/12-8g	Spring St., Sudbury	Hicks	188.5	Dn	24	2	Sand and gravel.
S103	S/12-8g	Hemlock Rd., Sudbury	Wayside Acres.	172.3	Dn	20	2	Sand
S104	S/12-8g	Poplar St., Sudbury	do	175.2	Dn	17	2	do
S105	S/12-8g	Dutton Rd., Sudbury	Mr. Kendall	180.3	Dn	12	1¼	do
S106	S/12-8g	do	N. Stacey	170.7	Dg		24	do
S107	S/12-7f	Craven La., north side of Hudson Rd., MOTS.	U.S. Army	230	Dr	150	6	Schist
S108	S/12-7j	Diagonal Rd., 200 ft west of Marlboro Brook, MOTS	do	188.9	Dn	6?	4	Clay, sand and gravel.
S109	S/12 7f	Top of hill, northeast corner, MOTS.	do	232.9	Dr	35		do
S110	S/12-7f	do	do	235.4	Dr	31		Silty sand and gravel.
S111	S/12-7j	About 1,350 ft east of RR; 800 ft north of Diagonal Rd., MOTS.	do	198.5	DnDr	18.8	1¼	do

Maynard area, Massachusetts—Continued

Water-bearing material—Continued	Ground-water level					Use	Other data and remarks
Geologic unit	Description of M.P.	Altitude of M.P. (feet)	Depth to water below MP (feet)	Altitude of water level (feet)	Date of measurement		
Sudbury—Continued							
Outwash	Top of cement casing	198.73	15.20	183.53	July 8, 1955	Dom	Top of casing, about 4.9 ft below land surface.
						Dom	
Outwash	Top of cement casing.		13.71		Apr. 27, 1953	Dom	Top of casing, 3.5 ft below land surface.
						Dom	
Outwash	Top of cement casing.		13.26		May 4, 1953	Dom	Top of casing, 7.5 ft below land surface.
do						Dom	Supplies 7 people.
do						Dom	
do						Dom	
do	Land surface		22		May 1953	Dom	
do	Top of concrete casing.		14.07		May 4, 1953	Dom	Supplies 4 people. Top of casing, 5.7 ft below land surface.
do	Top of cement casing.		20.1		May 4, 1953	Dom	Top of casing, 0.7 ft above land surface.
do	Top of cover		17.14		Mar. 15, 1955	Dom	Top of casing, 4.3 ft below land surface. 0–9 ft, gravel; 9–28 ft, sand.
do	Land surface		9.29		May 4, 1953	Dom	
do	Top of cement casing.	192.50	8.65	183.85	Oct. 1, 1955	Dom	
do	Hole in concrete cover.	185.88	2.52	183.36	Sept. 26, 1955	U	(W).
do	do	187.75	4.40	183.35	do	U	
do	Top of casing	203.09	19.28	183.31	Oct. 1, 1955	U	
do	Top of concrete casing.		13.45		July 14, 1955	Dom	Temperature of water 48.5° F., July 14, 1955.
do	Top of casing	189.41	15.60	173.81	Oct. 1, 1955	U	
do	do	172.38	5.83	166.55	do	Dom	
do	do	177.71	10.84	166.87	do	Dom	
do	do	178.89	5.98	172.91	do	Dom	
do	Cellar floor	167.72	.95	166.77	do	Dom	
Bedrock	Top of casing		17.40		Sept. 6, 1955	Dom	Top of casing, 7 ft below land surface.
Till	Wire across top of hole.	189.3	2.6	186.7	Sept. 26, 1955	Obs	Test boring FD-1. Uncased. Sounded depth, 6 ft, April 1955. (L), (W).
do						T	Test boring FD-2. Uncased. (L).
do						T	Test boring FD-3. Uncased.
Outwash	Top of casing	199.07				Obs	Test boring FD-4. Altitude of M.P. prior to Sept. 23, 1955, 202.37 ft. Rock at 68 ft (L), (H).

TABLE 9.—*Records of wells and test borings,*

Well	Location		Owner	Altitude of land surface (feet)	Well			Water-bearing material
	Symbol	Street and (or) area			Type	Depth (feet)	Diameter (in.)	Character
								Town of
S112	S/12-7h	106 ft east of RR; south of Diagonal Rd., MOTS.	U.S. Army	192.5	DnDr	22	1¼	Sand and gravel.
S113	S/12-7j	360 ft north of Marlboro Rd. and southeast corner of MOTS.	do	193.2	DnDr	28	1¼	Fine to coarse sand.
S114	S/12-7h	Diagonal Rd.; 230 ft west of RR, MOTS.	do	197.7	DnDr	26.5	1¼	Medium to coarse sand.
S115	S/12-7j	About 1,350 ft east of RR and Diagonal Rd., MOTS.	do	198.4	Dr	57	10	Sand and gravel.
S116	S/12-7j	3 ft north of S115, MOTS.	do	198.4	Dn,W	56	2½	do
S117	S/12-7j	43 ft southeast of S115, MOTS.	do	198.4	Dn,W	50	2½	do
S118	S/12-7j	50 ft southwest of S115, MOTS.	do	198.2	Dn,W	50	2½	do
S119	S/12-7j	do	do	198.2	Dn,W	20	2½	do
S120	S/12-7j	100 ft southwest of S115, MOTS.	do	197.6	Dn,W	20	2½	do
S121	S/12-7j	100 ft southwest of S115, MOTS.	do	197.6	Dn,W	49	4	Fine to medium sand.
S122	S/12-7j	300 ft southwest of S115, MOTS.	do	196.8	Dn,W	20	2½	Sand and gravel.
S123	S/12-7j	do	do	196.8	Dn,W	40	4	Fine silty sand.
S124	S/12-7j	About 440 ft north of S115, MOTS.	do	197	Dn,W	20	2½	Sand and gravel.
S125	S/12-7j	do	do	197	Dn,W	40	2½	Fine silty sand.
S126	S/12-7j	Diagonal Rd., 900 ft southeast of RR, MOTS.	do	197.9	Dn	16	1¼	Coarse sand.
S127	S/12-7f	640 ft north of Diagonal Rd.; 300 ft east of RR, MOTS.	do	199.8	Dn	13	1¼	Sand and gravel.
S128	S/12-7f	Hudson Rd., 402 ft west of east fence, MOTS.	do	200.9	Dn	7	1¼	Medium sand.

Maynard area, Massachusetts—Continued

Water-bearing material—Continued	Ground-water level					Use	Other data and remarks
Geologic unit	Description of M.P.	Altitude of M.P. (feet)	Depth to water below MP (feet)	Altitude of water level (feet)	Date of measurement		
Sudbury—Continued							
Outwash	Top of casing	197.05	5.48	191.57	Sept. 26, 1955	Obs	Test boring FD-5. Rock at 64 ft (L), (H).
do	do	198.20	14.63	183.57	do	Obs	Test boring FD-7. Rock at 67 ft (L), (H).
do	do	202.12	9.11	193.01	do	Obs	Test boring FD-8. Rock at 105 ft (L), (H).
do	do	199.73	11.09	187.94	Sept. 22, 1955	U	Supply well. Screen setting, 37-57 ft M.P. altitude, 199.03 ft prior to Sept. 29, 1955. (C). Temperature of works, 48.5 °F, Sept. 30, 1955.
do	do	198.86	10.69	188.17	Sept. 19, 1955	Obs	Well No. 1. Screen setting, 46-56 ft Well removed after pumping test. (L).
do	do	198.76	10.56	188.20	Sept. 18, 1955	Obs	Well No. 2. Screen setting, 46-50 ft Well removed after pumping test. (L).
do	do	200.04	12.11	187.93	Sept. 22, 1955	Obs	Well No. 3. Screen setting, 46-50 ft Well removed after pumping test. (L).
do	do	200.64	13.09	187.55	do	Obs	Well No. 4. Screen setting, 15½-20 ft Well removed after pumping test. S118, nearby.
do	do	200.71	13.15	187.56	do	Obs	Well No. 5. Screen setting, 15½-20 ft Well removed after pumping test. S121, nearby.
do	do	198.24	10.34	187.90	do	Obs	Well No. 6. Screen setting, 42-49 ft, diameter 1½ inches. Permanent well. (L).
do	do	197.22	9.77	187.45	do	Obs	Well No. 7. Screen setting, 15½-20 ft. Well removed after pumping test. S123, nearby.
do	do	199.04	11.63	187.41	do	Obs	Well No. 8. Screen setting, 36-40 ft. Well removed after pumping test. (L).
do	do	198.41	8.25	190.16	do	Obs	Well No. 9. Screen setting, 15½-20 ft. Well removed after pumping test. S125, nearby.
do	do	198.22	8.09	190.13	do	Obs	Well No. 10. Screen setting, 36-40 ft. Well removed after pumping test. (L).
do	do	200.89	12.69	188.20	Sept. 26, 1955	Obs	Well H.
do	do	202.78	10.14	192.64	do	Obs	Well I.
do	do	204.72	8.71	196.01	do	Obs	Well J.

TABLE 9.—*Records of wells and test borings,*

Well	Location: Symbol	Location: Street and (or) area	Owner	Altitude of land surface (feet)	Well: Type	Well: Depth (feet)	Well: Diameter (in.)	Water-bearing material: Character
								Town of
S129	S/12 -7h	Marlboro and Firehouse Rds., MOTS.	U.S. Army	193.4	Dn	8	1½	Coarse sand.
S130	S/12 -7j	150 ft east of Diagonal Rd., and 500 ft north of Marlboro Rd.	do	184.5	Dn	11	1¼	Sand and gravel.
S131	S/12 -7j	About 950 ft southwest of S115, MOTS.	do	192.6	Dn	22.5	1¼	do
S132	S/12 -7j	Marlboro and Diagonal Rds., MOTS.	do	191.7	Dn	12.9	1¼	Coarse sand.
S133	S/12 -7j	3 ft west of fence, southeast corner, MOTS.	do	197.5	Dn	5.5	1¼	Sand, gravel and clay.
S134	S/12 -7j	90 ft south of gaging station, X-10, MOTS.	do	184.8	Dn	16.5	1¼	Fine to medium sand.
S135	S/12 -7j	1,000 ft southeast of Marlboro Rd., southeast corner, MOTS	do	178.4	Dn	14.5	1¼	Medium sand.
S136	S/12 -7j	East fence, 770 ft north of Marlboro Rd.	do	195.2	Dn	20	1¼	Fine sand
S137	S/12 -7f	On baseline, 1,350 ft north of S115, MOTS.	do	199.6	Dn	17.7	1¼	Sand
S138	S/12 -7f	480 ft south of northeast fence corner, MOTS.	do	190.9	Dn	15	1¼	Sand and gravel.
S139	S 12 -7f	30 ft south of Hudson Rd. and east fence, MOTS.	do	195.2	Dn	16.5	1¼	Medium sand.
S140	S/12 -7j	About 720 ft northeast of S115, MOTS.	do	187.7	Dn	5.5	1¼	do
S141	S/12 -7f	East of RR, 30 ft south of Hudson Rd., MOTS.	do	197.2	DgDn	5	6 -1¼	Sand
S142	S/12 -7h	650 ft southwest of S126, MOTS.	do	189	Dn	8	1¼	do
S143	S/12 -8d	Butler Rd. Pine Lake	Unknown	195	Dg	18	1¼	do
S144	S/12 -7j	530 ft southeast of S115, MOTS.	U.S. Army	196.5	Dn	16.2	1¼	do
S145	S/12 -7j	940 ft northeast of S115, MOTS.	do	194.7	Dn	10.5	1¼	Sand and gravel.
S146	S/12 -7j	Near BMRR, 500 ft southeast of MOTS fence.	do	187.7	Dn	15.6	1¼	Silty sand
S147	S/12 -7j	60 ft north of Marlboro Brook gaging station, MOTS.	do	176	Dn	9	1¼	Sand
S148	S/11 -2c	About 2 miles southeast of MOTS.	Town of Sudbury.	145	Dn	34–62	2½	Sand and gravel.
S150	S/12 -7f	Classification yard, MOTS, about 900 ft north of Diagonal Road and 200 ft west of railroad tracks.	U.S. Geological Survey.	194	Dg	4	4	do
								Town
St1	S/12 —7e	Hudson Rd., 1,175 ft west of Sudbury Rd.	G Bruen	200.6	Dn	15	1¼	Sand
St2	S/12 —7e	Hudson and Sudbury Rds.	U.S. Army	203.5	Dn	17.3	1¼	do
St3	S/12 —7e	117 ft east of Concord Rd., 150 ft south of Hudson Rd., MOTS.	do	198.7	Dn	12.5	1½	Sand and gravel.
St4	S/12 —7e	730 ft south of Concord and Diagonal Rds., MOTS.	do	200	Dn	13	1¼	Sand
St5	S/12 —7e	100 ft north of Hudson Rd., 500 ft east of Concord Rd.	do	192	Dg	3	4	do

Maynard area, Massachusetts—Continued

Water-bearing material—Continued	Ground-water level					Use	Other data and remarks
Geologic unit	Description of M.P.	Altitude of M.P. (feet)	Depth to water below MP (feet)	Altitude of water level (feet)	Date of measurement		
Sudbury—Continued							
Outwash	Top of casing	196.44	5.63	190.81	Sept. 26, 1955	Obs	Well K.
do	do	187.99	9.55	178.44	do	Obs	Well L. (W).
do	do	193.78	9.75	184.05	do	Obs	Well M.
do	do	194.43	14.05	180.38	do	Obs	Well N.
Till	do	200.57	7.24	193.33	do	Obs	Well Q. Depth to water, uncertain. Till at 2 ft.
Outwash	do	187.68	13.00	174.68	do	Obs	Well P. (W).
do	do	181.22	11.84	169.38	do	Obs	Well Q.
do	do	197.73	15.64	182.09	Oct. 2, 1955	Obs	Well R.
do	do	201.58	13.76	187.82	Sept. 28, 1955	Obs	Well S.
do	do	193.93	12.56	181.37	Sept. 29, 1955	Obs	Well T.
do	do	197.98	13.15	184.83	Sept. 26, 1955	Obs	Well U.
do	do	190.91	4.30	186.61	Sept. 29, 1955	Obs	Well V.
do	Top of stove pipe casing.	197.73	3.17	194.56	Sept. 30, 1955	Obs	Well X. Well point at bottom of stove pipe.
do	Top of casing		7.5		Oct. 26, 1955	Obs	Well Y. Top of casing, 3.7 ft above land surface. Depth approximate.
do	do		15.55		Oct. 1, 1955	U	
do	do	199.57	12.84	186.73	Sept. 26, 1955	Obs	Well I-I′.
do	do	197.18	9.30	187.88	Sept. 29, 1955	Obs	Well V-V′. Temperature of water 50° F., Sept. 9, 1955.
do	do	191.88	15.85	176.03	Sept. 26, 1955	Obs	Well D-D′.
do	do	179.7	5.3	174.40	Oct. 24, 1955	Obs	Well C-C′. Depth approximate. (W).
do						PS	Series of about 23 wells near Hop Brook. (C).
do	Top of pipe		.92		Aug. 9, 1955	Obs	
of Stow							
Outwash	Top of casing	201.38	13.38	188.0	Oct. 1, 1955	U	Three other shallow wells on property.
do	do	204.37	14.55	189.82	Sept. 28, 1955	Obs	Well H-H′.
do	do	201.64	5.89	195.75	Sept. 26, 1955	Obs	Well A.
do	do		10.1		Oct. 24, 1955	Obs	Well B-B′. Depth approximate.
do	Top of stove pipe casing.	192.48	2.30	190.18	Sept. 30, 1955	Obs	Well G-G′.

TABLE 10.—*Logs of wells and test borings, Maynard area, Massachusetts*

[For other data, see table 9. Map coordinates refer to location shown on plate 1. Geologic correlations by N. M. Perlmutter]

	Thickness (feet)	Depth (feet)
H7. (S/12-7e.) Altitude 202.7 feet. Log prepared by H. G. Healy and N. M. Perlmutter.		
Recent deposits:		
Topsoil	0.3	0.3
Outwash:		
Sand, fine to medium, brown; some gravel and silt	1.7	2
Sand, very fine to coarse, brown; some gravel; silt (7 percent)	3	5
Sand, fine to medium, brown; some subrounded to subangular gravel and silt	5	10
Sand, fine to very coarse, brown, and gravel; silt (8 percent)	5	15
Sand, fine to medium, brown and gravel; some silt	5	20
Sand, very fine to fine, gray; and silt (25 percent)	1	21
Sand, very fine, brown; and silt (30 percent)	4	25
Sand, very fine, gray; and silt (34 percent)	4	29
Sand, very fine to medium, brown; and silt (12 percent)	1	30
Sand, very fine to fine, grayish-brown; and silt	5	35
Sand, fine to medium, grayish-brown; and silt (11 percent)	2	37
Sand, fine, gray; some silt	3	40
Sand, fine, some very fine, gray; and silt (46 percent)	5	45
Sand, fine, silty, grayish-brown	5	50
Sand, very fine, silty, grayish-brown	3	53
Sand, very fine to fine, silty, some coarse grains, gray	1	54
Sand, fine to medium, silty, some coarse grains, reddish-brown	1	55
Sand, very fine, brown; some silt	1	56
Sand, medium to very coarse, gray; some silt (7 percent)	1	57
Sand, medium to very coarse, brown; some silt; and a trace of gravel	1	58
Silt (96 percent); some very fine sand, gray	2	60
Silt, gray; and clay	3	63
Till:		
Silt, sand; and gravel	2	65
Sand, medium to coarse; silt; and gravel; gray	1	66
Sand, gray; silt (16 percent); and some gravel	4	70
Clay; silt; sand; and gravel; gray	2	72
Marlboro formation:		
Schist, phyllitic, weathered	12	84

TABLE 10.—*Logs of wells and test borings, Maynard area, Massachusetts*—Con.

	Thickness (feet)	Depth (feet)
H15. (S/12-7h). Altitude 193 feet. Log prepared by Corps of Engineers, U.S. Army.		
Recent deposits:		
Fill	1	1
Topsoil	1	2
Outwash:		
Sand, medium, gray; few pebbles	8	10
Sand, silty, brown	4	14
Sand, medium, gray	9	23
Sand, fine, gray	13	36
S50. (S/12-8d). Altitude 202 feet. Log reported by owner.		
Recent deposits:		
Topsoil	2	2
Outwash:		
Sand, heavy, light yellow	3	5
Gravel, coarse	4	9
Clay, yellow, dry	3	12
Gravel	4	16
Clay, light blue	2	18
Sand, fine; and water	3	21
S108. (S/12-7j). Altitude 189 feet. Log prepared by Corps of Engineers, U.S. Army.		
Recent deposits:		
Topsoil, peaty, brownish-black	1	1
Till(?):[1]		
Sand, medium compact, gravelly, silty, brown to brownish-gray; a few cobbles	9	10
Till:		
Sand, gravelly, silty, compact to very compact, gray	15	25
S109. (S/12-7f). Altitude 233 feet. Log prepared by Corps of Engineers, U.S. Army.		
Recent deposits:		
Sand, gravelly, silty, brown; some organic material	2	2
Till:		
Sand, gravelly, silty, grayish-brown; cobbles	13	15
Sand, gravelly, clayey, grayish-brown to gray; cobbles (no water)	20	35

[1] Small number of blows per foot of penetration suggests that some outwash may be present immediately below soil zone.

TABLE 10.—*Logs of wells and test borings, Maynard area, Massachusetts*—Con.

	Thickness (feet)	Depth (feet)
S111. (S/12-7j). Altitude 198.5 feet. Log prepared by H. G. Healy and N. M. Perlmutter.		
Recent deposits:		
Topsoil	3	3
Outwash:		
Sand, very fine to medium, some coarse grains, brown; some silt; and a few small pebbles	2	5
Sand, fine to medium, some coarse grains, brownish-gray; gravel; and some silt (8 percent)	5	10
Sand, fine to medium, dark brown; some silt (7 percent); and some fine to coarse gravel	1	11
Sand, fine, some medium grains, dark-gray; some gravel	2	13
Sand, medium, some coarse grains, reddish-brown; and silt (15 percent)	2	15
Sand, silty, very fine to fine, yellow	2	17
Gravel, very coarse, sandy, gray; and silt (16 percent)	3	20
Sand, coarse, brown; some fine to coarse gravel	5	25
Sand, medium to very coarse, gray, and fine gravel	5	30
Sand, medium to very coarse, and fine gravel	5	35
Sand, medium to very coarse, brown, and gravel; some silt	5	40
Sand, coarse to very coarse, brown; some large gravel and silt	5	45
Sand, very coarse, brown, and gravel; some silt (9 percent)	5	50
Gravel, sandy, silty, gray	5	55
Sand, medium to very coarse, gray; some fine to coarse gravel and gray silt	3	58
Till:		
Gravel and sand, fine to medium, silty, gray; trace of clay	2	60
Gravel, sandy and silty, gray, compact	8	68
Marlboro formation:		
Schist, quartz-mica, dark-gray; fractured	15	83
S112. (S/12-7h). Altitude 192.5 feet. Log prepared by H. G. Healy and N. M. Perlmutter.		
Recent deposits:		
Topsoil, sandy; some organic material	3	3
Outwash:		
Sand, very fine to fine, gray; and silt (21 percent)	2	5
Sand, medium to very coarse, gray; trace of silt (4 percent) and gravel	5	10
Sand, fine to coarse, greenish-gray; trace of silt (4 percent) and gravel	5	15
Sand, fine to medium, some coarse to very coarse, greenish-gray, and gravel; and silt (9 percent)	5	20
Sand and gravel, fine to medium, some coarse grains, brown; trace of silt (4 percent)	5	25

TABLE 10.—*Logs of wells and test borings, Maynard area, Massachusetts*—Con.

	Thickness (feet)	Depth (feet)
S112. (S/12-7h). Altitude 192.5 feet. Log prepared by H. G. Healy and N. M. Perlmutter—Continued		
Till:		
Sand, fine to medium, gray; silt (36 percent); gravel; compact	2	27
Sand, fine to coarse, gray; silt; gravel; compact	3	30
Sand, clay, and silt, gray; some gravel	5	35
Silt, and some very fine sand, compact greenish-gray	5	40
Sand, fine to medium, silt (45 percent), dark greenish-gray; gravel	5	45
Sand, fine to medium, clay, and silt, greenish-gray; some gravel	12	57
Sand, fine to coarse, greenish-gray; silt (39 percent); gravel	7	64
Marlboro formation:		
Schist, quartz-mica	20	84
S113. (S/12-7j). Altitude 193.2 feet. Log prepared by H. G. Healy and N. M. Perlmutter.		
Recent deposits:		
Topsoil, sandy, brown	2	2
Outwash:		
Sand, fine to coarse, brown; some gravel	2. 5	4. 5
Sand, fine to medium, grayish-brown; and silt (16 percent)	1. 5	6
Sand, medium to coarse, some very coarse, brown; few pebbles	4	10
Sand, fine to coarse, brown	4	14
Sand, fine to medium, grayish-brown; some gravel; trace of silt	1	15
Sand, very fine to fine, gray; trace of silt	5	20
Sand, fine to medium, gray; trace of silt	5	25
Sand, fine to medium, greenish-gray; trace of silt	1	26
Sand, fine to medium gray; and silt (11 percent)	2	28
Silt (95 percent); very fine sand, gray	32	60
Gravel; some very coarse sand; silt (3 percent); gray	5	65
Till:		
Sand, medium, gray; silt (25 percent); and gravel; compact	2	67
Aplite(?):		
Granite, pink	11	78

TABLE 10.—*Logs of wells and test borings, Maynard area, Massachusetts*—Con.

	Thickness (feet)	Depth (feet)
S114. (S/12–7h). Altitude 197.7 feet. Log prepared by Corps of Engineers, U.S. Army.		
Recent deposits:		
Topsoil, loose, black	0.5	0.5
Outwash:		
Sand, gravelly, loose, brown; some silt	1.5	2
Sand, fine to coarse, brown, loose; some gravel	10	12
Sand, fine to medium, gravelly, loose, brown; trace of silt (5 percent)	1	13
Sand, fine to medium, brown; some silt	2	15
Sand, fine to medium, brown	5	20
Sand, fine to medium, brown; some gravel	3	23
Sand, medium to coarse, gray; some gravel	4	27
Silt, gray; and very fine to fine sand in thin layers (64 to 83 percent silt)	55	82
Till:		
Sand, fine to coarse, gray; gravel; and silt (37 percent); compact	1	83
Silt, sandy, gray; gravel; compact	2	85
Sand, silty, gray; gravel; compact	10	95
Gravel, sandy, gray; and silty (34 percent)	10	105
Marlboro formation:		
Schist, dark-gray, some weathered zones	14	119
S116. (S/12–7j). Altitude 198.4 feet. Log prepared by N. M. Perlmutter.		
Outwash:		
Sand, fine to coarse, grayish-brown; some gravel	15	15
Sand, medium to coarse; some gravel	5	20
Sand, medium to coarse, gray; gravel	4	24
Sand, coarse, gray; and gravel	8	32
Sand, coarse, rusty-brown	8	40
Sand, medium to coarse, brown; and some gravel	8	48
Sand, coarse to very coarse, gray; and some gravel	8	56
Sand, very fine, gray; and some gravel	2	58
S117. (S/12–7j). Altitude 198.4 feet. Log prepared by N. M. Perlmutter.		
Outwash:		
Sand, medium to coarse, grayish-brown; some gravel	16	16
Sand, medium to coarse, rusty-brown; trace of gravel	4	20
Sand, very fine to fine gray; and silt	12	32
Sand, fine to coarse, brown; and gravel	8	40

TABLE 10.—*Logs of wells and test borings, Maynard area, Massachusetts*—Con.

	Thickness (feet)	Depth (feet)
S118. (S/12-7j). Altitude 198.2 feet. Log prepared by N. M. Perlmutter.		
Outwash:		
Sand, fine to coarse, brown; some gravel	24	24
Sand, fine to medium, gray; trace of silt	8	32
Sand, medium to very coarse, brown	8	40
Sand, medium to coarse, grayish-brown; and gravel	10	50
S121. (S/12-7j). Altitude 197.6 feet. Log prepared by N. M. Perlmutter.		
Outwash:		
Sand, medium to very coarse, brown; some gravel	16	16
Sand, medium to coarse, brown	8	24
Sand, fine to medium, grayish-brown	8	32
Sand, fine to medium, some coarse particles, gray; trace of silt	8	40
Sand, fine to medium, gray; trace of silt	10	50
S123. (S/12-7j). Altitude 196.8 feet. Log prepared by N. M. Perlmutter.		
Outwash:		
Sand, medium to coarse, brown; and gravel	16	16
Sand, medium to coarse, brown; some gravel	4	20
Sand, medium to coarse, brown	4	24
Sand, fine to medium, light brown	8	32
Sand, fine, silty, gray	10	42
Sand, fine, silty and clayey, gray	8	50
S125. (S/12-7j). Altitude 197 feet. Log prepared by N. M. Perlmutter.		
Outwash:		
Sand, medium to coarse, brown; and gravel	24	24
Sand, fine, gray, silty; some medium	8	32
Sand, very fine, silty, gray	8	40
Sand, very fine, silty and clayey, gray; few pieces of tough clay near bottom	10	50

TABLE 11.—*Records of water-level fluctuations in observations wells, Maynard area, Massachusetts*

[Water levels and altitudes of measuring points are given in feet above mean-sea-level datum of 1929]

H8. Driven observation well, in outwash deposits, diameter 1¼ inches, depth 11.6 feet. In Maynard Ordnance Test Station, east side of Concord Road, about 13 feet south of observation well H7. (S/12-7e). Measuring point is top of well casing, about 2 feet above land surface, altitude 204.50 feet.

Date	Water level	Date	Water level	Date	Water level
1955		*1956*		Apr. 27	194.96
Sept. 26	[1] 192.99	Jan. 4	192.84	June 1	193.96
Nov. 30	193.87	Jan. 27	193.89	June 29	193.30
		Apr. 3	194.00		

H10. Driven observation well in outwash deposits, diameter 1¼ inches, depth 8 feet. In Maynard Ordnance Test Station, west side of fire lane from Administration area to White Pond and about 150 feet north of Concord Road. (S/12-7h). Measuring point is top of well casing, about 4.5 feet above land surface, altitude 200.53 feet.

Date	Water level	Date	Water level	Date	Water level
1955		*1956*		Apr. 27	192.59
Sept. 3	191.33	Jan. 4	190.55	June 1	192.01
Sept. 9	191.04	Jan. 27	191.66	June 29	191.16
Sept. 13	190.89	Feb. 28	191.80		
Sept. 26	190.53	Apr. 3	192.10		

S98. Dug used well, in outwash deposits, diameter 36 inches, depth 14 feet. In Pine Lake area, about 300 feet north of Hudson Road and 250 feet east of Maynard Ordnance Test Station fence. (S/12-7f). Measuring point is hole in concrete cover over well, about 7 feet below land surface, altitude 185.88 feet.

Date	Water level	Date	Water level	Date	Water level
1953		*1955*		*1956*	
July 6	184.9	July 25	182.57	Jan. 4	183.30
		Aug. 5	182.06		
		Aug. 22	184.04		
		Sept. 6	183.88		
		Sept. 26	183.36		

S108. Drilled uncased hole in till, diameter 4 inches, depth about 6 feet. In Maynard Ordnance Test Station, about 200 feet southesat of culvert at Marlboro Brook and Diagonal Road, and about 25 feet west of Diagonal gravel road. (S/12-7j). Measuring point is wire across top of hole, altitude 189.3 feet.

Date	Water level	Date	Water level	Date	Water level
1955		Aug. 5	(2)	Feb. 28	187.91
June 9	[1] 186.1	Aug. 23	188.10	Apr. 3	187.35
June 13	[1] 187.07	Sept. 12	186.61	Apr. 27	187.07
June 17	[1] 186.48	Sept. 26	186.74	June 1	186.84
June 27	186.59	Nov. 30	186.89	June 29	186.29
July 5	186.23				
July 11	186.17	*1956*			
July 18	185.84	Jan. 4	186.11		
July 25	184.74	Jan. 27	186.89		

S130. Driven observation well, in outwash deposits, diameter 1¼ inches, depth 11 feet. In Maynard Ordnance Test Station, about 150 feet northeast of Diagonal Road and 500 feet northwest of Marlboro Road. (S/12-7j). Measuring point is top of well casing, about 3.5 feet above land surface, altitude 187.99 feet.

Date	Water level	Date	Water level	Date	Water level
1955		*1956*		Apr. 27	180.61
Sept. 12	178.97	Jan. 4	178.57	June 1	179.19
Sept. 14	178.86	Jan. 27	179.81	June 29	178.69
Sept. 26	178.44	Feb. 28	179.56		
Sept. 29	178.45	Apr. 3	179.72		

[1] Estimated.
[2] Dry.

TABLE 11.—*Records of water-level fluctuations in observations wells, Maynard area, Massachusetts*—Continued

S134. Driven observation well, in outwash deposits, diameter 1¼ inches, depth 16.5 feet. In Maynard Ordnance Test Station, about 90 feet south of stream-gaging station on Marlboro Creek. (S/12-7j). Measuring point is top of well casing, about 2½ feet above land surface, altitude 187.68 feet.

Date	Water level	Date	Water level	Date	Water level
1955		*1956*		Apr. 3	174.91
Sept. 12	174.88	Jan. 4	174.69	Apr. 27	175.78
Sept. 26	174.68	Jan. 27	174.80	June 1	175.50
Nov. 30	175.13	Feb. 28	174.75	June 29	174.89

S147. Driven observation well in outwash deposits, diameter 1¼ inches, depth about 9 feet. In Maynard Ordnance Test Station, about 60 feet north of Marlboro Brook at stream-gaging station. (S/12-7j). Measuring point is top of well casing, about 3 feet above land surface, altitude 179.7 feet. (hand-level measurement).

Date	Water level	Date	Water level	Date	Water level
1955		*1956*		Apr. 3	174.4
Oct. 24	173.4	Jan. 4	174.0	Apr. 27	174.8
Nov. 30	173.4	Jan. 27	174.3	June 1	174.5
		Feb. 28	174.3	June 29	174.1

TABLE 12.—*Records of water-level fluctuations in ponds and swamps, Maynard area, Massachusetts*

[Water levels are given in feet above mean sea level. Map coordinates refer to location on plate 1]

X-1. Swamp, Maynard Ordnance Test Station, about 400 feet north of firehouse and about 550 feet east of Concord Road. (S/12-7h). Measuring point is top of wooden stake, altitude 192.89 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 12	192.59				

X-3. Swamp, Maynard Ordnance Test Station, west side of fire lane about 600 feet north of intersection of Concord Road. (S/12-7h). Measuring point is top of wooden stake, altitude 192.96 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 12	192.33				

X-5. Pond in abandoned sand pit, Massachusetts Department of Conservation DDT plant, about 450 feet west of Concord Road and 400 feet south of Hudson Road. (S/12-7e). Measuring point is top of wooden stake, altitude 192.85 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 12	191.91				

X-6. Pond, Maynard Ordnance Test Station, about 100 feet north of intersection of Concord Road and Diagonal Road. (S/12-7e). Measuring point is red mark on stone, altitude 195.69 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 12	193.48				

X-8. Pond in heart-shaped swamp in Maynard Ordnance Test Station, about 800 feet north of well S111 and 1,200 feet east of railroad tracks in classification area. (S/12-7j). Measuring point is top of wooden stake, altitude 191.41 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 12	190.37				

TABLE 12.—*Records of water-level fluctuations in ponds and swamps, Maynard area, Massachusetts*—Continued

X-9. Marlboro Brook, Maynard Ordnance Test Station, near well S130, about 250 feet north of Diagonal Road and about 550 feet northwest of extension of Marlboro Road. (S/12-7j). Measuring point is top of wooden stake, altitude 176.17 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 13	175.59				

X-10. Marlboro Brook, near stream-gaging station, southeastern part of Maynard Ordnance Test Station, about 300 feet west of intersection of Marlboro Road and southeast boundary of Test Station. (S 12-7j). Measuring point is mark at graduation 3.34 feet on staff gage, altitude 176.01 feet.

Date	Water level	Date	Water level	Date	Water level
1955		July 25	172.99	*1956*	
May 16	173.15	Aug. 4	172.87	Jan. 4	173.19
May 23	173.12	Aug. 16	172.97	Jan. 27	173.17
May 24	173.09	Aug. 23	173.49	Feb. 28	173.19
June 13	173.15	Aug. 30	173.26	Apr. 3	173.27
June 18	173.05	Sept. 12	173.15	Apr. 27	173.31
June 27	173.05	Sept. 26	173.11	June 1	173.21
July 5	173.02	Oct. 13	173.20	June 29	173.07
July 11	173.03	Nov. 30	173.21		
July 18	172.99				

X-12. Pond in swamp, Maynard Ordnance Test Station, south side of Hudson Road and about 800 feet west of U.S. Army railroad crossing. (S 12-7f.) Measuring point is yellow mark on top of concrete culvert, altitude 199.72 feet.

Date	Water level	Date	Water level	Date	Water level
1955		Oct. 10	196.11		
Sept. 26	196.04				

X-13. Creek, south side of Hudson Road and about 400 feet east of U.S. Army Railroad crossing. (S/12-7f). Measuring point is yellow mark on top of concrete culvert, altitude 196.22 feet.

Date	Water level	Date	Water level	Date	Water level
1955		Oct. 10	192.61		
Sept. 26	192.54				

X-14. Marlboro Brook, about 20 feet south of crossing beneath Marlboro Road, near southeastern corner of Maynard Ordnance Test Station. (S/12-7j). Measuring point is top of wooden lath, altitude 169.74 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 4	167.59				

X-15. Pond in swamp, in Maynard Ordnance Test Station, about 800 feet south of Hudson Road and 120 feet east of railroad tracks in classification area. (S/12-7f). Measuring point is top of wooden stake, altitude 195.08 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 13	194.28				

X-16. Pond, Maynard Ordnance Test Station, about 100 feet west of railroad tracks in classification area and 1,100 feet south of Hudson Road. (S/12-7f). Measuring point is top of wooden stake, altitude 194.44 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 13	193.64				

X-18. Pond in swamp, 30 feet west of White Pond Road and Boston and Maine Railroad tracks. (S/12-7h). Measuring point is top of wooden stake, altitude 190.40 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 14	189.44				

TABLE 12.—*Records of water-level fluctuations in ponds and swamps, Maynard area, Massachusetts*—Continued

X-19. Pond in swamp, north side of Boston and Maine Railroad tracks about 600 feet west of White Pond Road. (S/12-7g). Measuring point is top of wooden stake, altitude 191.08 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 12	190.43				

X-20. Brook, east side of Concord Road, about 1,000 feet south of Boston and Maine Railroad tracks. (S/12-7g). Measuring point is orange square on stone culvert, altitude 193.61 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 10	184.76				

X-21. Swamp, 1,150 feet south of Hudson Road and 100 feet east of White Pond Road. (S/12-7g). Measuring point is top of wooden lath, altitude 193.96 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 5	191.00				

X-22. Boons Pond, southeastern part, about 200 feet north of Hudson Road and 800 feet east of White Pond Road. (S/12-7e). Measuring point is red mark on stone flood wall, altitude 189.90 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 1	186.19	Oct. 7	186.45		

X-23. Swamp, east side of Sudbury Road, about 600 feet north of Hudson Road. (S/12-7e). Measuring point is red mark on top of stone culvert, altitude 191.86 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 2	190.66	Oct. 8	190.91		

X-30. Hop Brook, east side of Dutton Road, at Stearns Mill. (S/12-8g). Measuring point is red mark on east wall of stone bridge, altitude 155.98 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 2	148.05				

X-31. Stearns Mill Pond, Dutton Road. (S/12-8g). Measuring point is mark on north side of dam, altitude 158.29 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 2	156.39				

X-33. Creek, east side of Marlboro Road, near Haskell property, about 2,000 feet south of Hudson Road. (S/12-8g). Measuring point is top of wooden lath, altitude 161.61 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 3	158.96				

X-34. Creek, about 800 feet west of Marlboro Road, and 2,000 feet south of Hudson Road. (S/12-8d). Measuring point is top of wooden lath, altitude 166.58 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 3	166.13				

TABLE 12.—*Records of water-level fluctuations in ponds and swamps, Maynard area, Massachusetts*—Continued

Date	Water level	Date	Water level	Date	Water level

X-36. Pond in Marlboro Creek, about 550 feet southeast of Marlboro Road. (S/12–7j). Measuring point is orange mark on dam at southeast end of pond, altitude 168.94 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 4	166.94				

X-37. Marlboro Creek, about 50 feet east of dam at southeast end of small pond (X36). (S/12–7j). Measuring point is top of wooden lath, altitude 162.13 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 4	159.41				

X-38. Hop Brook at Boston and Maine Railroad bridge, 1,700 feet west of Dutton Road, Sudbury. (S 12–7j). Measuring point is mark on north side of trestle at center line of brook, altitude 168.60 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 3	157.20				

X-39. Pond in swamp, about 250 feet west of Dutton Road and 30 feet north of Boston and Maine Railroad tracks. (S 11–2a). Measuring point is top of wooden lath, altitude 170.21 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 3	167.18				

X-40. Hop Brook, about 700 feet south of Boston and Maine Railroad tracks and 1,300 feet east of Concord Road. (S 12–7h). Measuring point is top of wooden stake, altitude 171.14 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 3	170.84				

X-41. Brook, south side of Concord Road, about 1,600 feet southwest of Boston and Maine Railroad tracks. (S 12–7h). Measuring point is orange mark on stone culvert, altitude 181.90 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 4	180.30				

X-42. Swamp, south side of Boston and Maine Railroad tracks and about 1,000 feet east of White Pond Road. (S 12–7h). Measuring point is top of wooden stake, altitude 187.43 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Oct. 14	186.88				

X-45. Brook, near center of eastern fence line of Maynard Ordnance Test Station. (S 12–7j). Measuring point is top of wooden stake, altitude 176.62 feet.

Date	Water level	Date	Water level	Date	Water level
1955					
Sept. 29	175.47				

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