Estimated Short-Term Yields of and Quality of Ground Water in Stratified-Drift Aquifer Areas in the Neponset River Basin, Massachusetts

By ALAN R. KLINGER

U.S. Geological Survey
Water-Resources Investigations Report 93-4142

Prepared in cooperation with the
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL MANAGEMENT,
OFFICE OF WATER RESOURCES

Marlborough, Massachusetts
1996

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

For additional information, write to:

District Chief
Massachusetts—Rhode Island District
U.S. Geological Survey
Water Resources Division
28 Lord Rd., Suite 280
Marlborough, MA 01752

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
cubic foot (ft^3)	0.02832	cubic meter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
gallon per minute (gal/min)	0.06308	liter per second
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
million gallons per day (Mgal/d)	0.04381	cubic meter per second
square mile (mi^2)	2.590	square kilometer
cubic foot per day per square foot times foot of aquifer thickness $[(ft^3/d)/ft^2]ft$ (reduces to ft^2/d)	0.09290	cubic meter per day per square meter times meter of aquifer thickness

To convert cubic feet per second to million gallons per day, multiply by 0.6463

Sea Level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Estimated Short-Term Yields of and Quality of Ground Water in Stratified-Drift Aquifer Areas in the Neponset River Basin, Massachusetts

By Alan R. Klinger

Abstract

This report presents the estimated short-term yields and quality of ground water in stratified-drift aquifer areas in the Neponset River Basin, Massachusetts. Stratified glacial drift forms the major aquifer areas in the basin. These thin valley-fill aquifer areas of sand and gravel have saturated thicknesses of as much as 130 feet and widths that reach a maximum of 8,000 feet in some of the bedrock valleys.

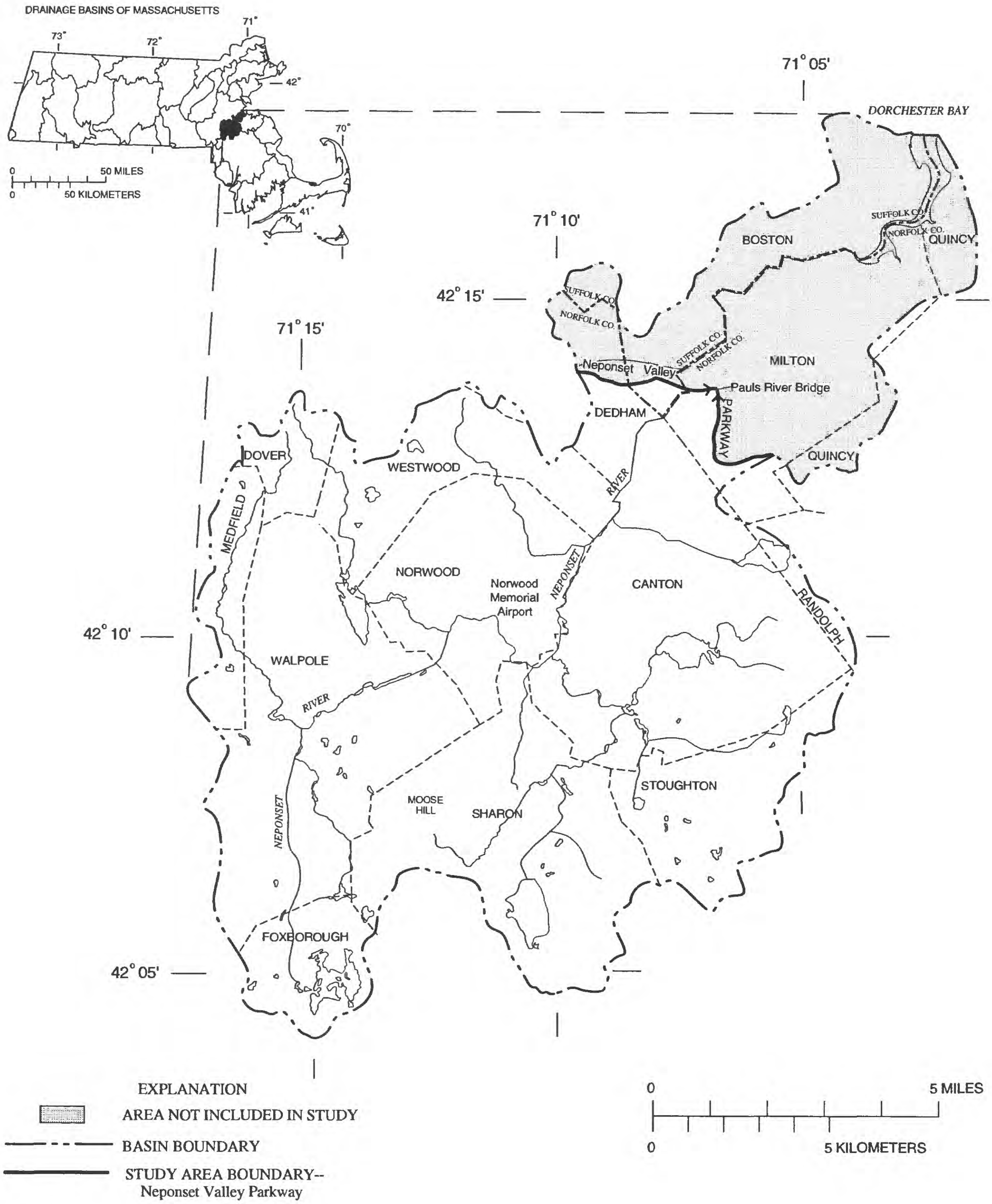
For 14 selected aquifer areas, estimated short-term yields from aquifer storage, which is representative of short-term duration yield available during severe drought conditions, ranged from 2.1 to 12.4 cubic feet per second after 30 days of pumping and from 0.3 to 7.1 cubic feet per second after 180 days of pumping.

Ground water in the basin tends to be slightly acidic, of low to moderate hardness, and has relatively low concentrations of dissolved solids. Sodium is the dominant cation and chloride the dominant anion. In one-half of the wells sampled, iron and manganese concentrations exceeded the U.S. Environmental Protection Agency Secondary Maximum Contaminant Levels (SMCL's) of 300 and 50 micrograms per liter, respectively.

INTRODUCTION

Intermittent water shortages in the Neponset River Basin (fig. 1) are common. Except for the towns of Norwood and Canton, which receive water from the Massachusetts Water Resources Authority, all towns in the study basin rely on ground water as their sole source of public supply. Shortages occur because the aquifers are small and discontinuous, water use has been increasing, short-term droughts prevent replenishment of depleted aquifer storage, and anthropogenic ground-water contamination has limited use of supplies. If water resources are not fully identified and management programs pursued, water-supply problems are projected to increase (Massachusetts Department of Environmental Management, 1983).

This report presents the results of a study conducted during 1985-88 to estimate the short-term yields and describe the quality of ground water in stratified-drift aquifer areas in the Neponset River Basin. Only that part of the basin upstream from Paul's Bridge on the Neponset Valley Parkway in Milton was examined, omitting Quincy, and most of Boston and Milton (fig. 1). The omitted area was not examined because of its urban development and resulting unsuitability for municipal wells. This basin



Base from U.S. Geological Survey digital line graphs, 1:100,000, 1988
Universal Transverse Mercator projection, Zone 19

Figure 1. Location of the Neponset River Basin, Massachusetts.

study is one of a series to assess the State ground-water resources under Massachusetts Chapter 800 legislation. Work was done by the U.S. Geological Survey (USGS) in cooperation with the Massachusetts Department of Environmental Management, Office of Water Resources. The author thanks the town engineers and employees of the municipal water departments in the basin for providing information on ground-water exploration and development in their communities. Thanks also to those property owners who permitted access to their property for seismic-refraction surveying, monitor-well installation, and streamflow measuring.

Undeveloped, major stratified-drift aquifer areas in the basin were studied in detail. Short-term aquifer yields were estimated for 14 of the 15 aquifer areas previously described by Brackley and others (1973a). Quality of ground water was described using analyses for inorganic chemical constituents, specific conductance, pH, alkalinity, trace elements, and volatile organic compounds.

Numerous reports describing ground-water conditions in the basin's municipalities have been prepared by private consulting firms. Among these include reports by Amory Engineers (1979); Geraghty and Miller, Inc. (1966, 1982, 1983); Linenthal, Eisenberg, and Anderson, Inc. (1984); Weston and Sampson (1980); and Whitman and Howard, Inc. (1939, 1973).

DESCRIPTION OF STUDY AREA

Location and Water Use

The Neponset River Basin (fig. 1) drains 117 mi^2 southwest of Boston in eastern Massachusetts. It includes all or part of the towns of Canton, Dedham, Dover, Foxborough, Medfield, Milton, Norwood, Randolph, Quincy, Sharon, Stoughton, Walpole, Westwood, and the city of Boston. The total drainage area of the study basin, that part of the Neponset River Basin upstream from Paul's Bridge on the Neponset Valley Parkway in Milton, is 93.2 mi^2.

The basin is in the Seaboard Lowland Section of the New England Physiographic Province. Land-surface altitudes range from about 40 ft above sea level along parts of the Neponset River in the eastern part of the basin to 470 ft above sea level on Moose Hill in Sharon. Surface-water drainage of the Neponset River generally is northeast to Dorchester Bay. Mean annual discharge of the Neponset River at Norwood is 53.9 ft^3/s. Average annual precipitation at the Norwood Airport is 43.7 in. and is distributed fairly evenly throughout the year (National Oceanic and Atmospheric Administration, 1987).

Land use is primarily residential with moderate industrial and commercial activity. In 1986, average daily demand for water in the towns in the study area was 38.1 ft^3/s and the maximum daily demand was about 55.5 ft^3/s. Of the average 38.1 ft^3/s used, 24.8 ft^3/s was derived from ground-water resources in the basin. This amount derived from the basin's ground-water resources has remained fairly constant since 1970 and probably will not increase substantially. Overall, water use (including water imported from other river basins) in the towns of the basin increased 14 percent from 1970 through 1986 and is expected to increase 23 percent over 1986 water-use levels by the year 2020 (Massachusetts Department of Environmental Management, 1988).

Geohydrologic Setting

Bedrock underlying the Neponset River Basin is predominantly igneous and sedimentary. The bedrock is relatively impermeable and is only moderately weathered and fractured (Chute, 1966). Numerous private bedrock wells in the study area are used for domestic water supply. These wells typically yield only a few gallons per minute (Brackley and others, 1973b). Therefore, bedrock aquifers in the Neponset River Basin are not suitable for large municipal supplies and were not included in this study.

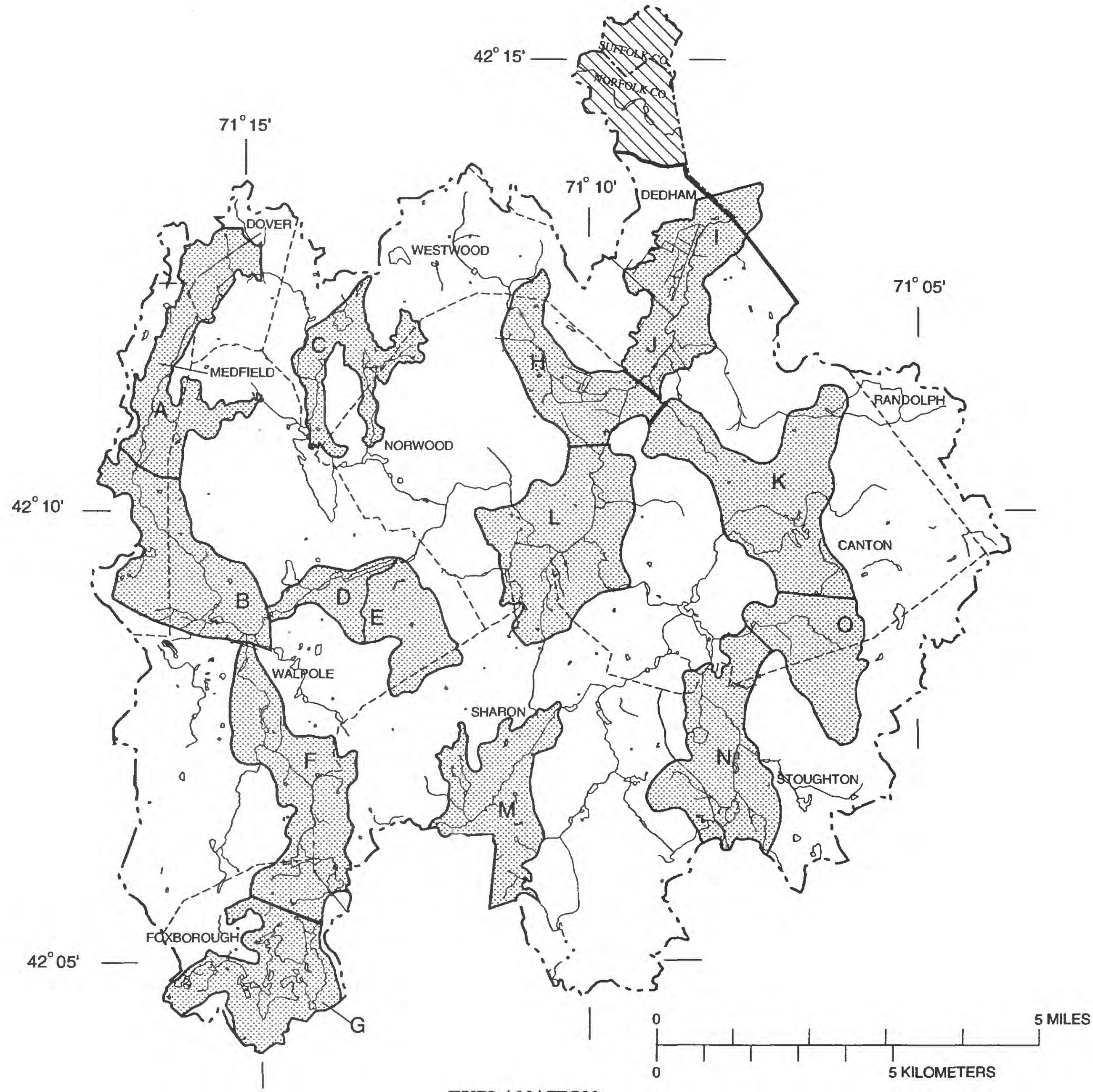
Bedrock is overlain by unconsolidated glacial deposits, primarily till and stratified drift. Till, an unsorted mixture of sand, gravel, silt, clay, and rock fragments, is the sole surficial deposit over nearly 50 percent of the basin. In addition, till underlies most of the other surficial deposits (Chute, 1966). Till has low permeability and is not considered an aquifer.

Stratified-drift deposits consist of cobbles, gravel, sand, silt, and clay of Pleistocene and Holocene age. These deposits are exposed at land surface over about 30 percent of the basin. The stratified-drift deposits are narrow and thin, reaching a maximum thickness of 130 ft in some of the bedrock valleys (Chute, 1966). Widths range from 0.1 to 1.3 mi and lengths range from about 0.7 to 2.5 mi. Yields of wells in the fine-grained stratified drift are usually no more than a few gallons per minute, whereas yields of wells in the coarse-grained stratified drift can exceed 300 gal/min (Lapham, 1988) and form the only aquifer areas in the basin capable of sustaining municipal water supplies.

Recharge of ground water to the stratified-drift aquifers is primarily from infiltration of precipitation. Ground water moves through the aquifer and discharges into streams, lakes, and wetlands. Ground water withdrawn from the stratified-drift aquifers is derived from intercepted ground-water discharge, induced infiltration of surface water and aquifer storage.

AQUIFER AREAS

Fifteen aquifer areas shown in figure 2 were identified from a ground-water-favorability study conducted by Brackley and others (1973a). Transmissivity of the aquifer areas was remapped on the basis of the map by Brackley and others (1973a, and test drilling and seismic surveys conducted during this study, and records of test-drilling by others that were collected. The seismic profiles in figure 3 were used to determine the saturated thickness of seven of the aquifer areas. The distribution of transmissivity in the 15 aquifer areas is shown in figures 3*A-M*.



EXPLANATION

AREA OF BASIN NOT INCLUDED IN STUDY

AQUIFER AREA AND LETTER DESIGNATION

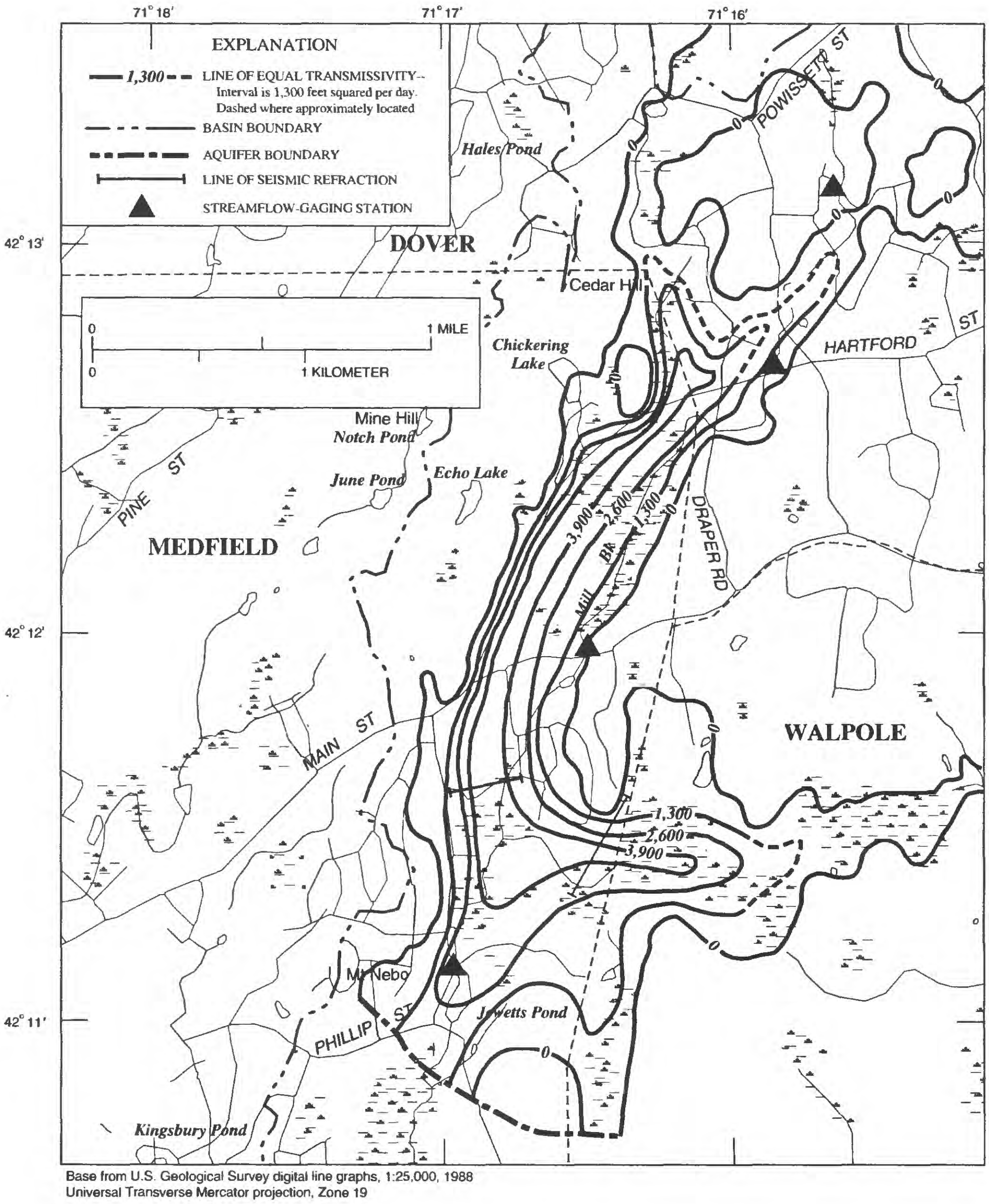
- A Mill Brook
- B Turner Pond
- C Germany Brook
- D Bird Pond
- E Traphole Brook
- F School Meadow Brook
- G Neponset Reservoir
- H Purgatory Brook
- I Fowl Meadow Reservation
- J White Lodge
- K Reservoir Pond
- L Central Neponset River
- M Beaver Brook aquifer
- N Steep Hill Brook aquifer
- O Beaver Meadow Brook aquifer

BASIN BOUNDARY

STUDY AREA BOUNDARY-- Neponset Valley Parkway

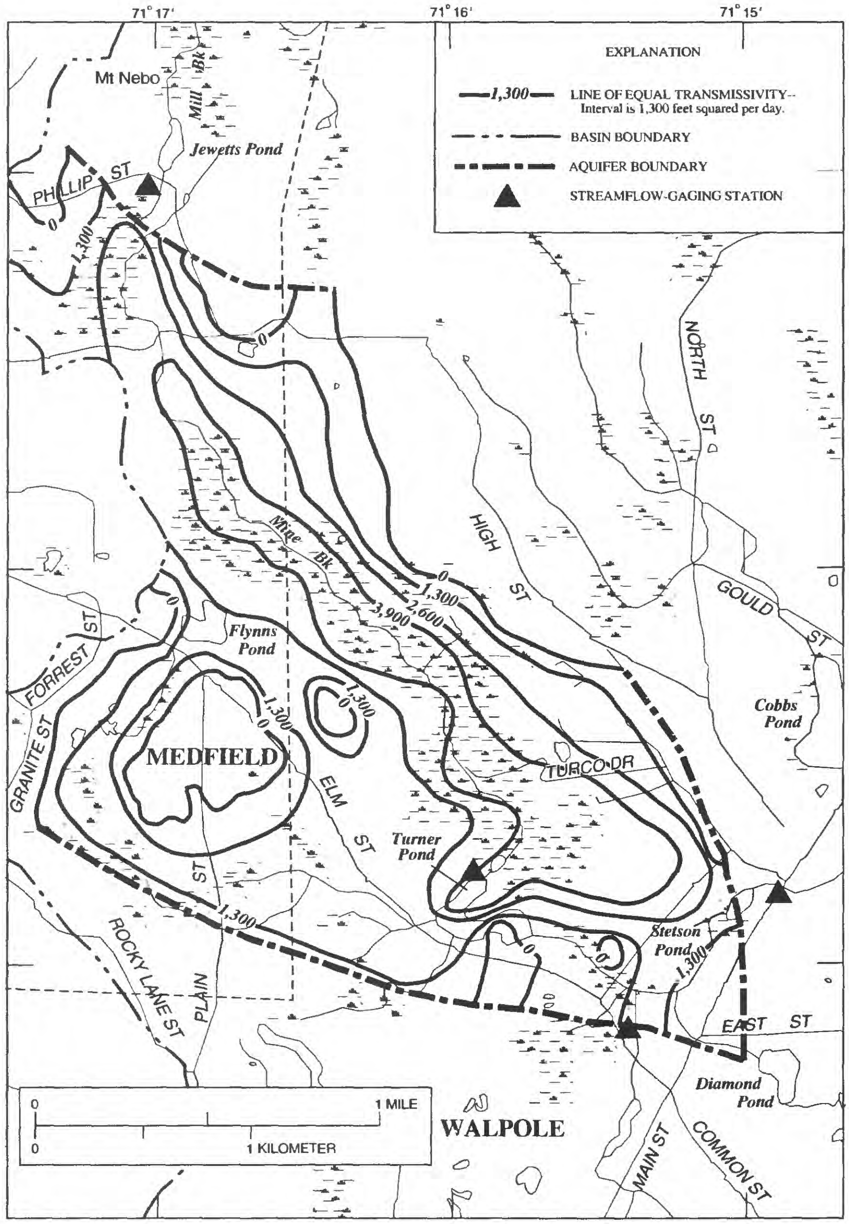
Base from U.S. Geological Survey digital line graphs, 1:100,000, 1988
Universal Transverse Mercator projection, Zone 19

Figure 2. Names and locations of the 15 stratified-drift aquifer areas in the Neponset River Basin, Massachusetts.



3*A*. Mill Brook aquifer area.

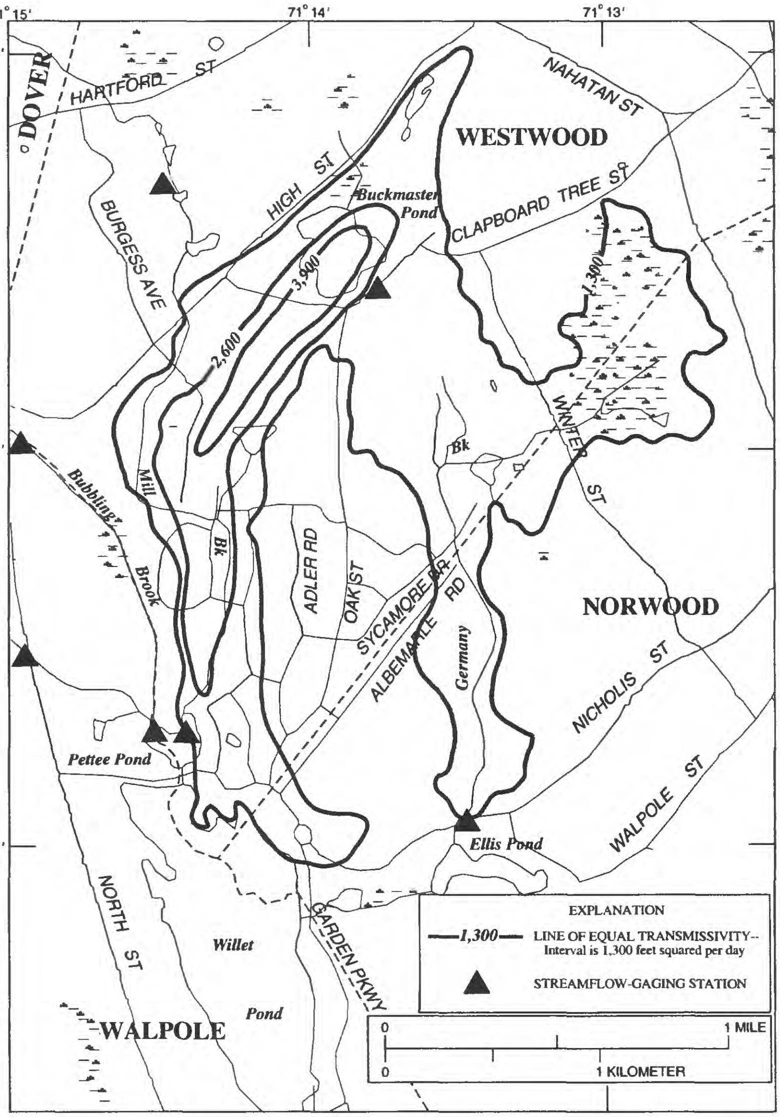
Figure 3. Distribution of transmissivity for the 15 stratified-drift aquifer areas in the Neponset River Basin, Massachusetts. (Modified from Brackley and others, 1973a.)



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*B*. Turner Pond aquifer area.

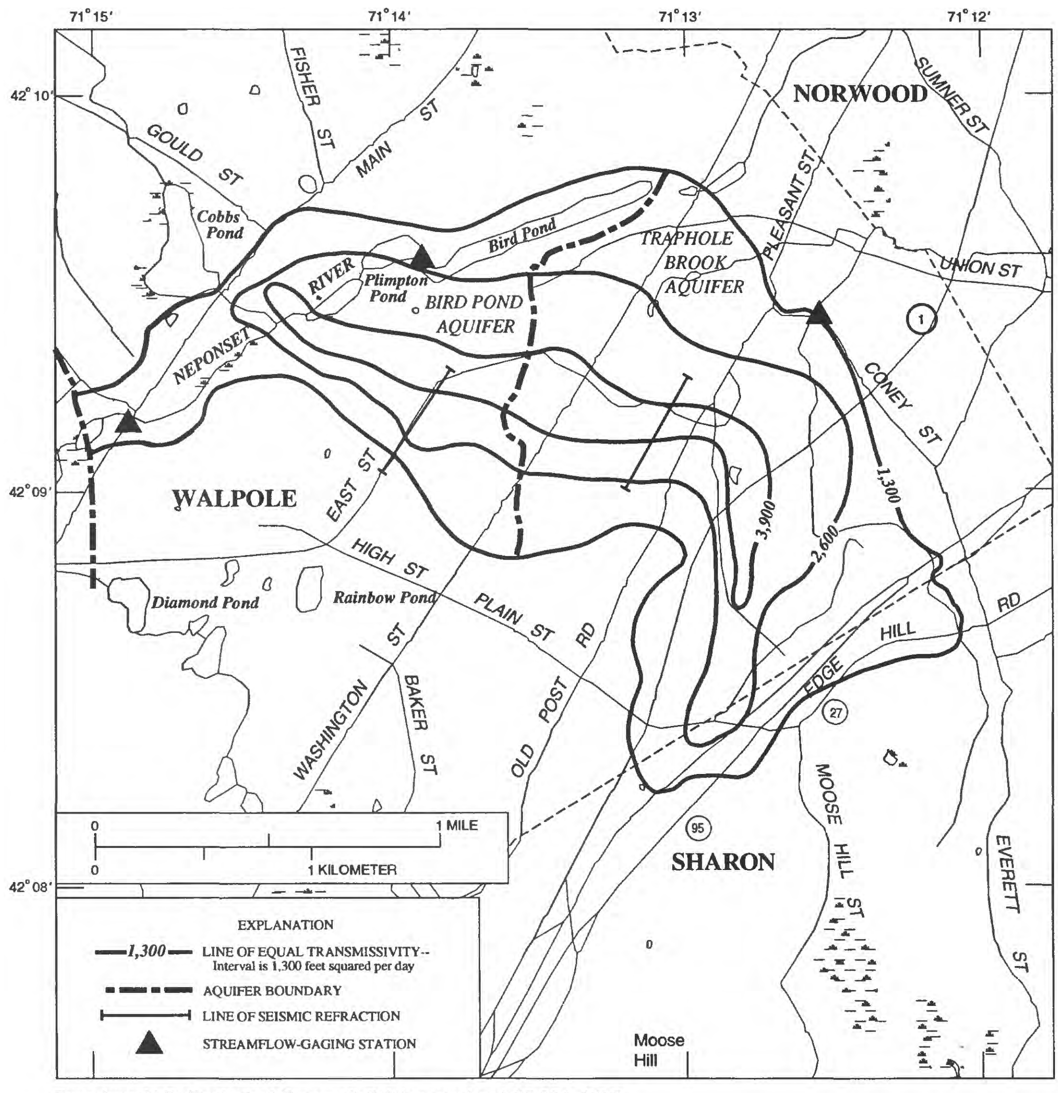
Figure 3. —*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*C*. Germany Brook aquifer area.

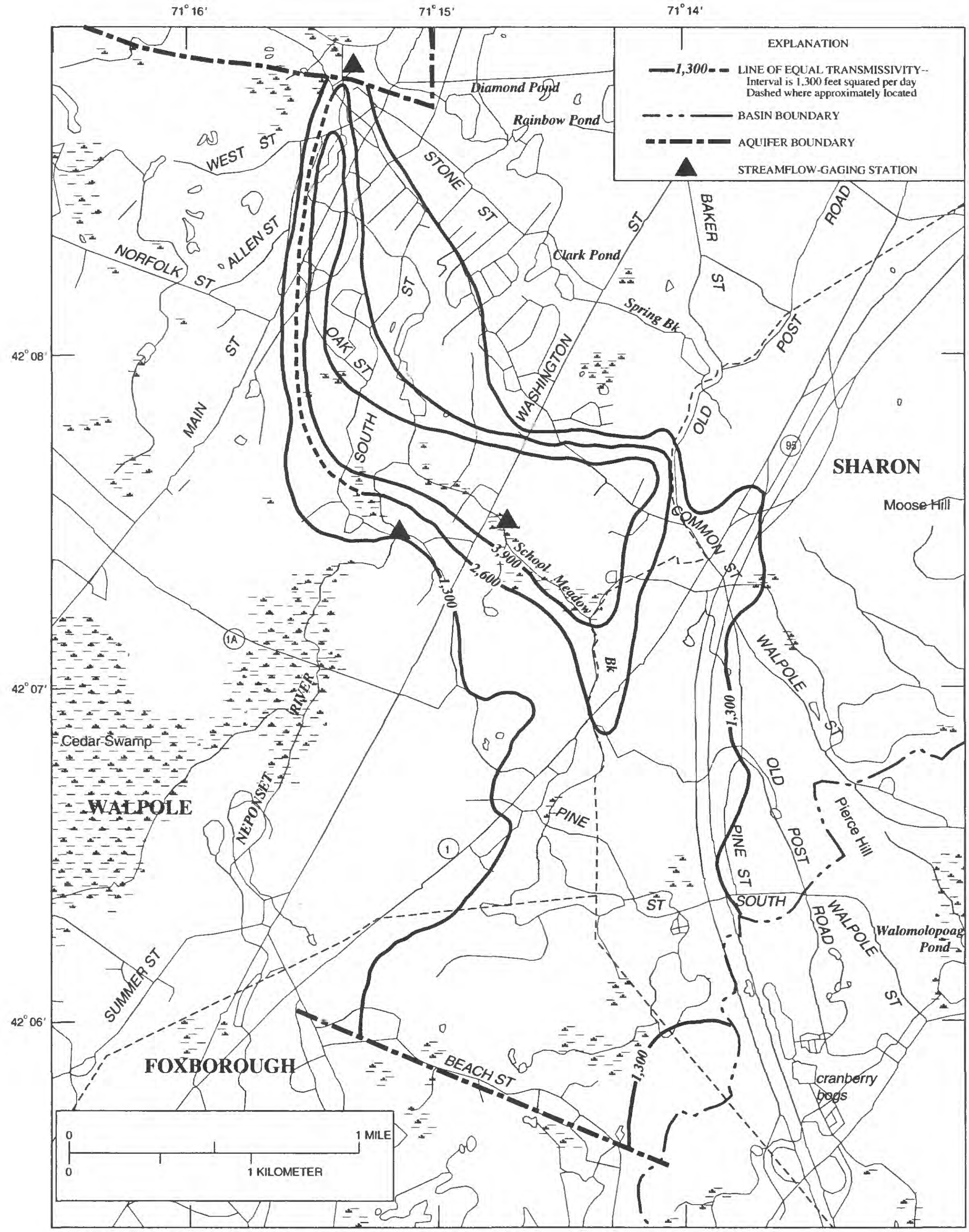
Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*D*. Bird Pond and Traphole Brook aquifer areas.

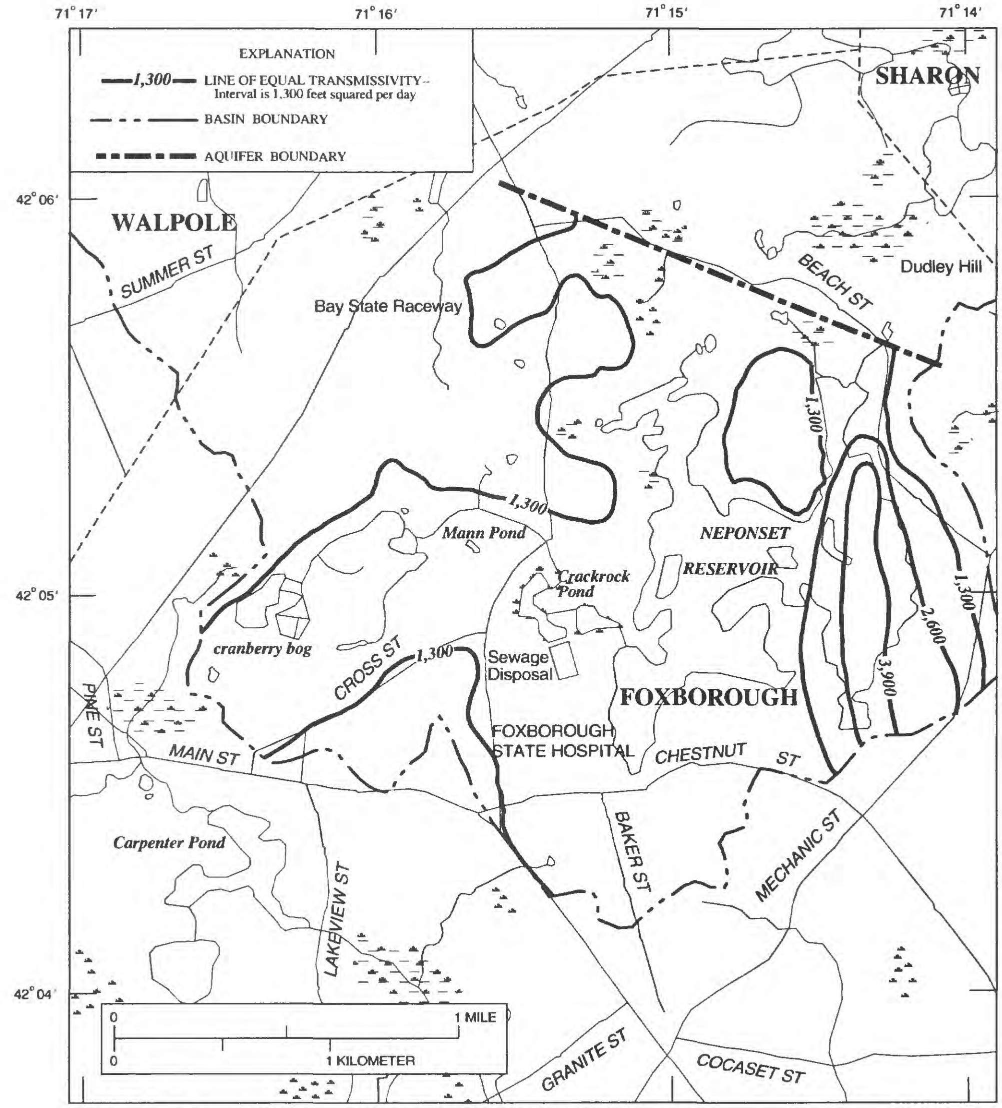
Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3E. School Meadow Brook aquifer area.

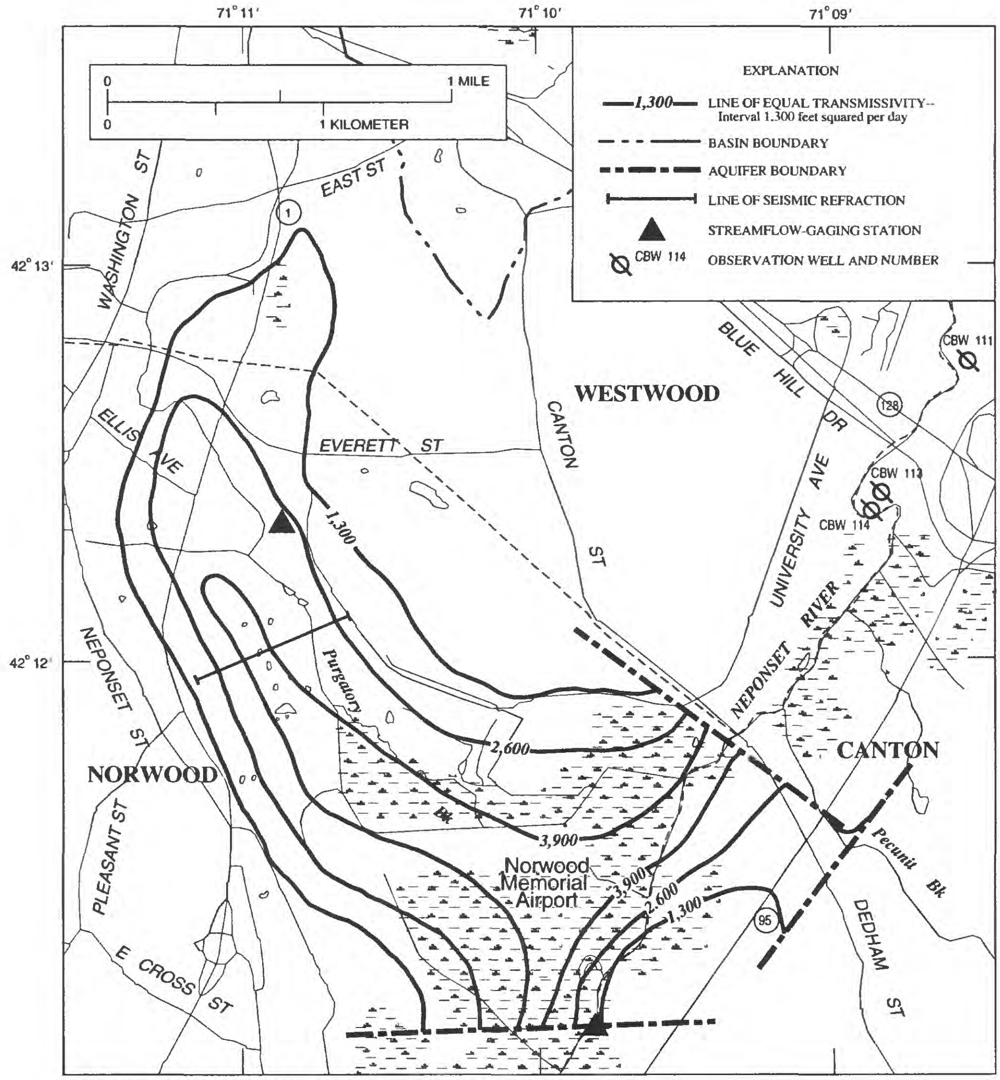
Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*F*. Neponset Reservoir aquifer area.

Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
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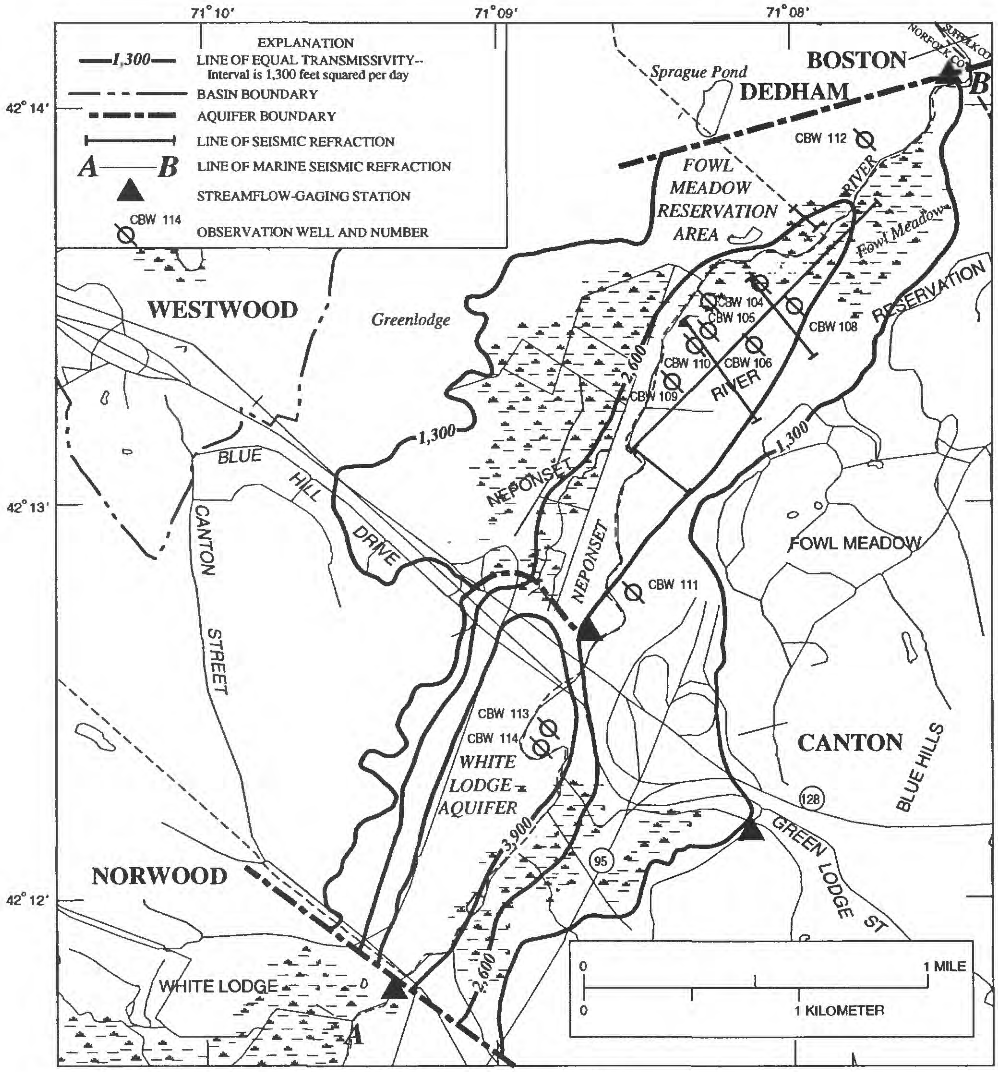
3*G*. Purgatory Brook aquifer area.

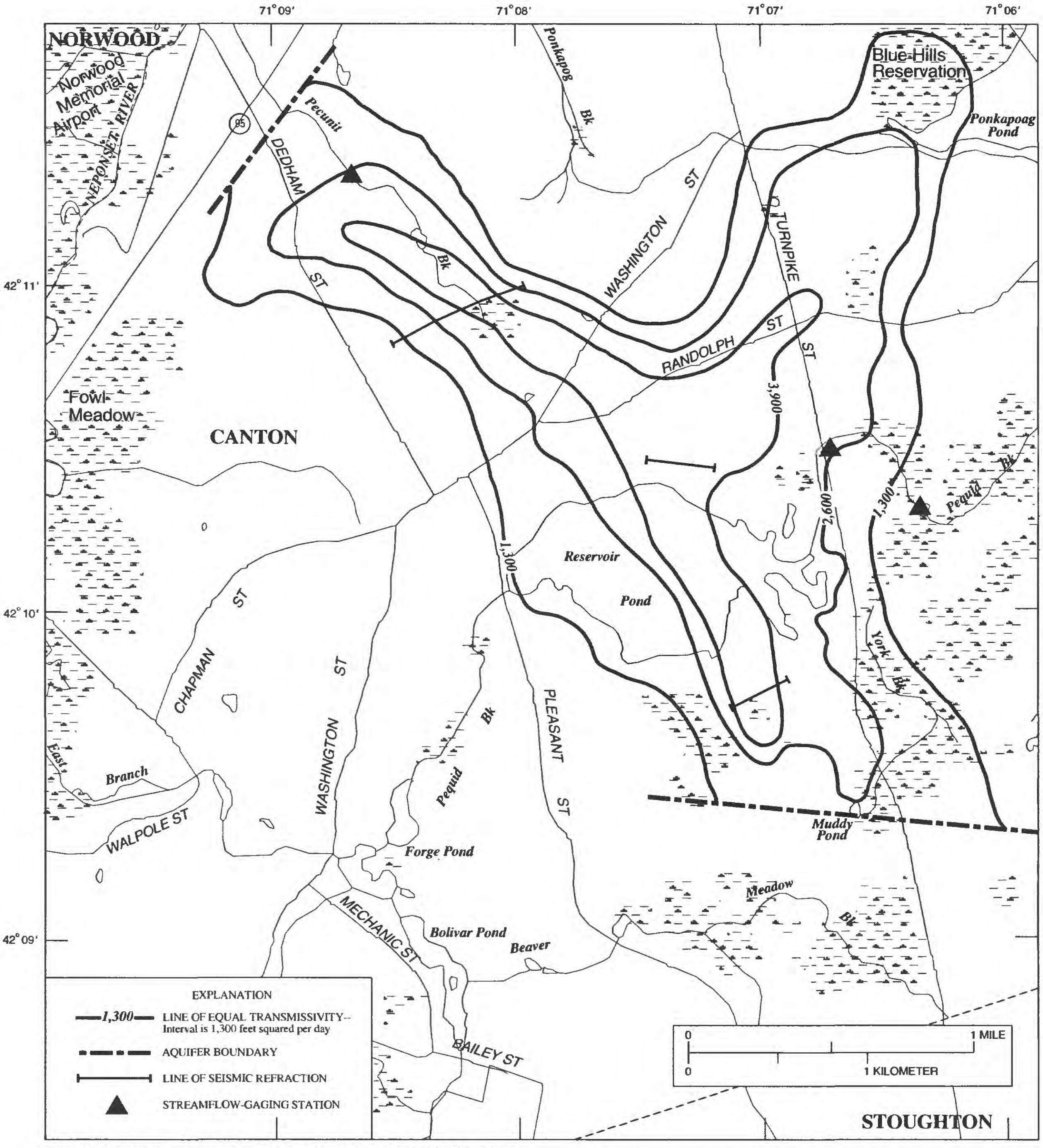
Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*H*. Fowl Meadow Reservation area and White Lodge aquifer area.

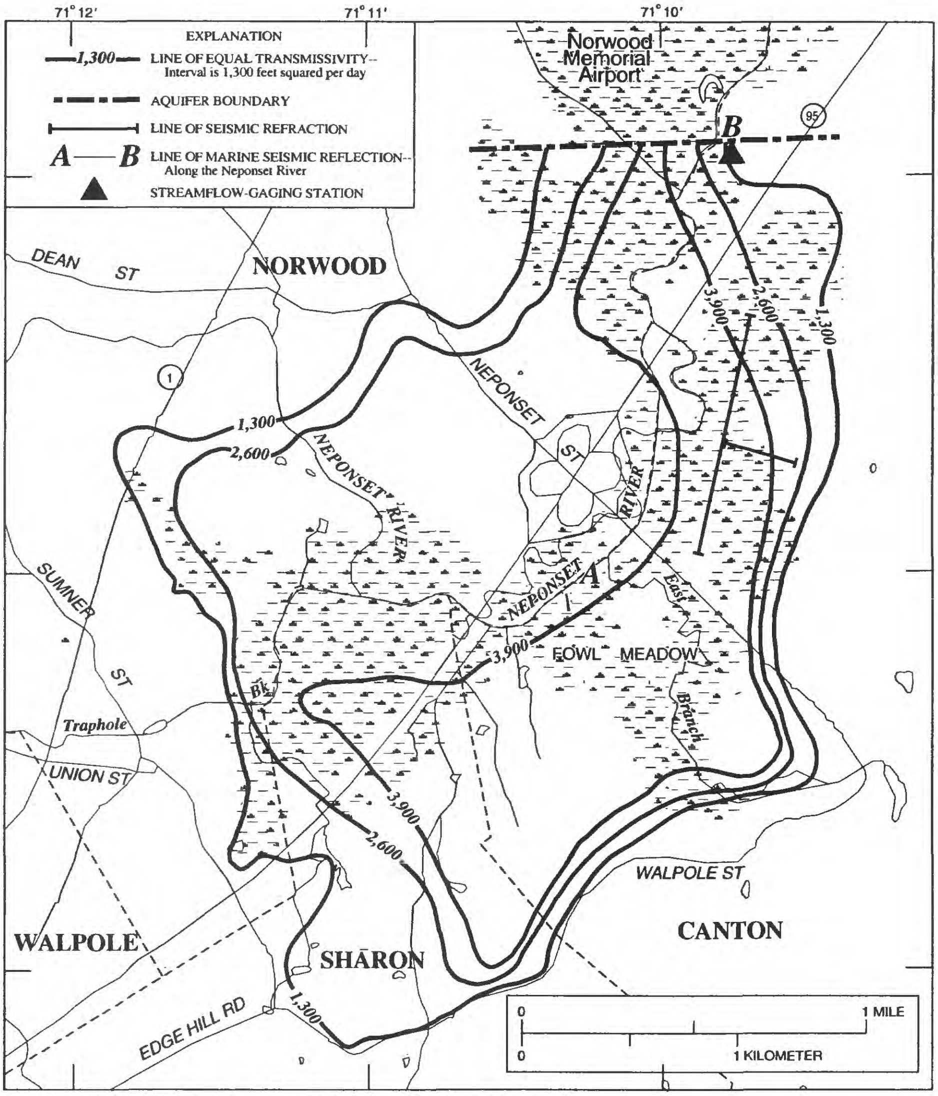
Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*l*. Reservoir Pond aquifer area.

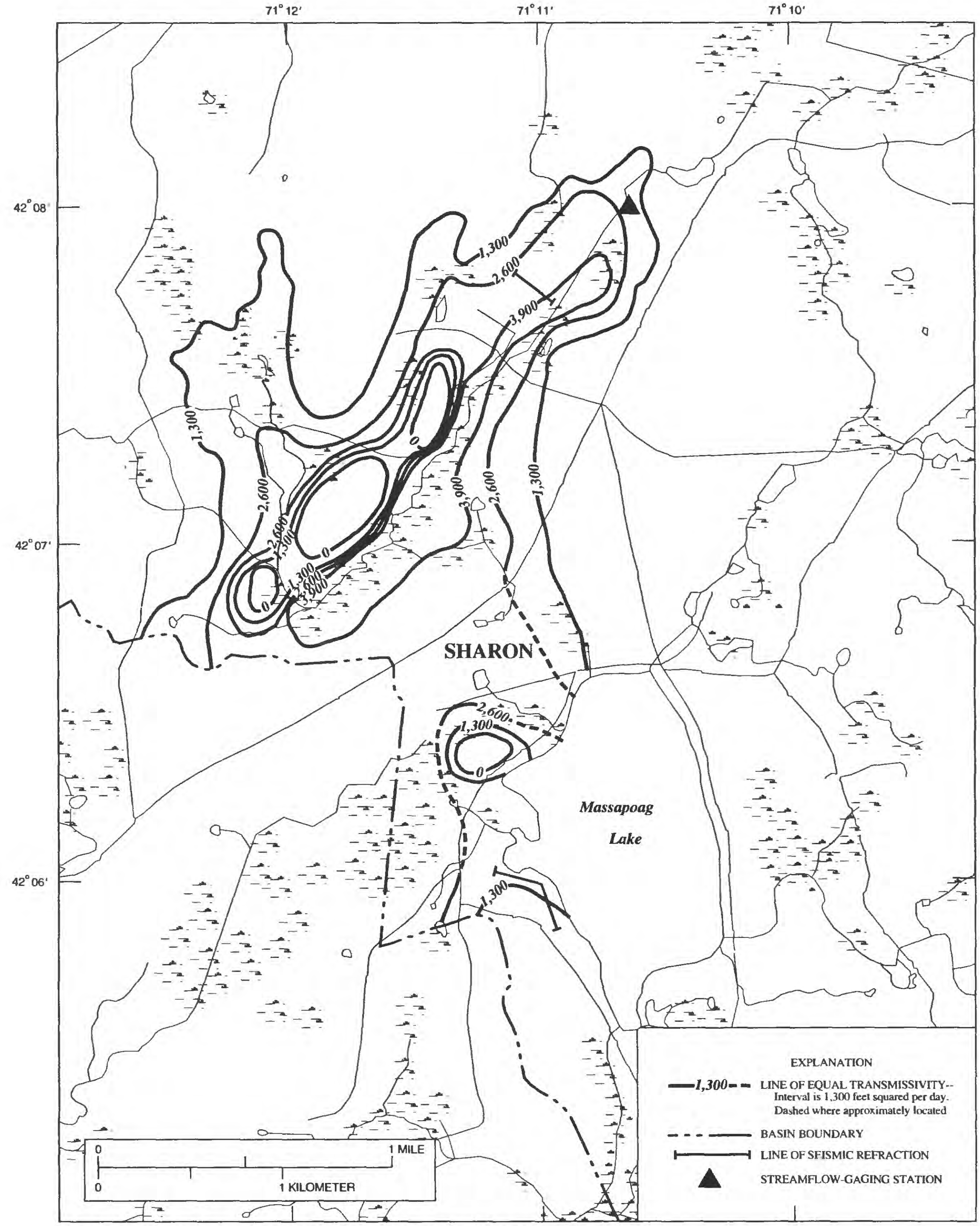
Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*J.* Central Neponset River aquifer area.

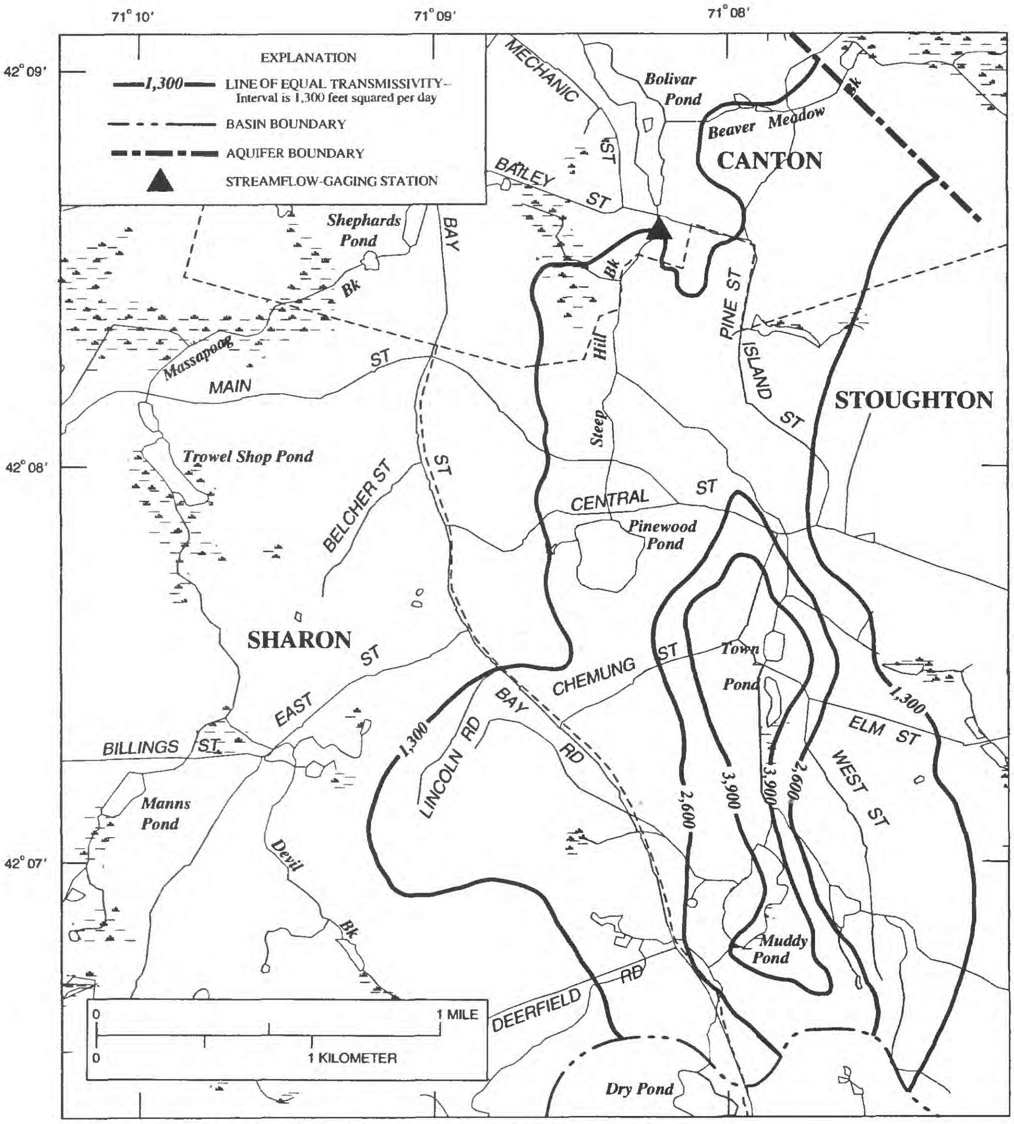
Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*K*. Beaver Brook aquifer area.

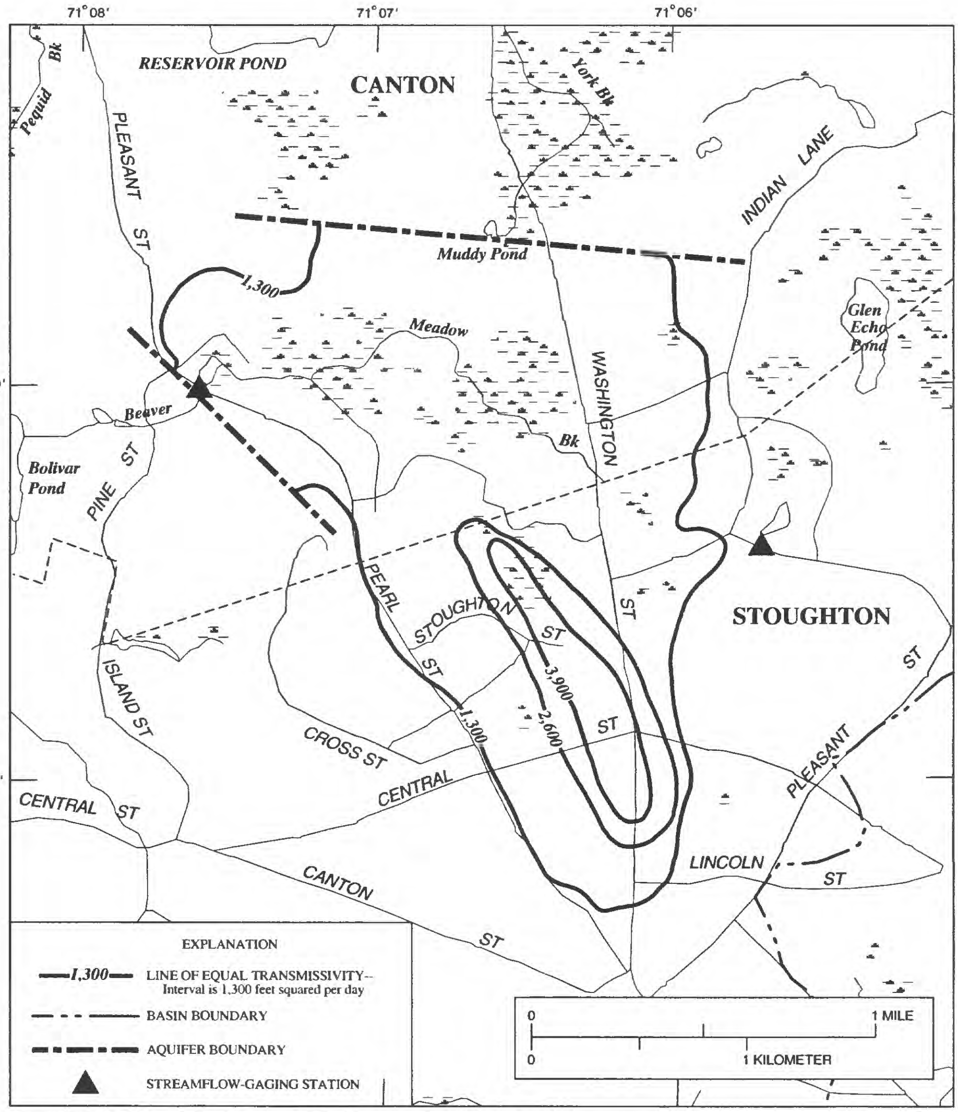
Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*L*. Steep Hill Brook aquifer area.

Figure 3.—*Continued.*



Base from U.S. Geological Survey digital line graphs, 1:25,000, 1988
Universal Transverse Mercator projection, Zone 19

3*M*. Beaver Meadow Brook aquifer area.

Figure 3.—*Continued.*

SHORT-TERM YIELDS OF STRATIFIED-DRIFT AQUIFER AREAS

During severe drought, ground-water recharge and discharge is small, streamflow is low, and little surface water is stored in wetlands. Consequently, water pumped from aquifers under these conditions is derived from aquifer storage. In this report, estimates of short-term aquifer yields were based on water available solely from depletion of aquifer storage.

Freeze and Cherry (1979) define aquifer yield as the maximum rate of withdrawal that can be sustained without causing an unacceptable decline in the hydraulic head of an aquifer. In this study, an unacceptable decline in the hydraulic head of an aquifer is defined as a greater than 50 percent decline in the water table in an aquifer near the pumped well. This value was selected for consistency with similar areal studies of stratified-drift aquifer yields in the Taunton (Lapham, 1988), Nashua (de Lima, 1989) and Blackstone (Izbicki, in press) River Basins.

Fourteen of the potential 15 aquifer areas were selected for analysis of short-term aquifer yields. Criteria used for selecting an area for analysis was the presence of at least 40 ft of saturated aquifer material that had a transmissivity of at least 3,000 ft^2/d and a horizontal hydraulic conductivity of the stratified drift of at least 100 ft/d where the well screen would be placed.

The Fowl Meadow Reservation area (area I in fig. 2) was the only area determined unsuitable for analysis based on the above criteria. Lithologic logs of 11 wells drilled in this area during the project (table 1) indicate a saturated thickness of about 100 feet composed of mostly low hydraulic conductivity fine sands and silts that yield only small quantities of water to wells.

The short-term yields of the 14 selected aquifer areas (fig. 3) were calculated using a ground-water-flow model (McDonald and Harbaugh, 1988), with yields expressed as a single value for several selected pumping periods. By design, the two-dimensional model developed for each aquifer is only a tool to estimate aquifer yield. These models have not been calibrated with respect to extensive ground-water-level data bases and the sensitivity of model output to changes in hydraulic properties of aquifer areas has not been evaluated. In addition, changes in the free-surface boundary that simulates the water table are nonlinear, and therefore, not additive (Reilly and others, 1987). These models, therefore, can not be used to predict specific changes in water-table configuration resulting from proposed ground-water pumping plans, regardless of whether the initial water-table configuration is known. Results from these models are more similar to results obtained using image-well models than results obtained from fully calibrated ground-water-flow models. Because of these limitations on model use, details of model construction usually provided as part of ground-water-modeling studies have not been included in this report.

The calculations of short-term aquifer yields were based on the following assumptions about the aquifer areas and ground-water flow in each aquifer area:

1. Stratified-drift aquifer areas are homogeneous and isotropic. Distribution of aquifer transmissivity is shown in figure 3.
2. Ground-water flow is horizontal; therefore, a two-dimensional model was used.
3. No ground water flows to or from the till and bedrock; therefore, the aquifer areas were simulated as being surrounded by no-flow boundaries. Aquifer areas are bounded by a line of equal transmissivity of 1,300 ft^2/d (fig. 3).
4. There is neither recharge nor streamflow, and neither are simulated.
5. The water table in each aquifer is considered to be flat prior to pumping and is simulated as such.

Table 1. Lithologic logs of test holes in the Fowl Meadow Reservation area, Neponset River Basin, Massachusetts

[Location of wells shown in figure 3*H*. ft, foot. Description: Refusal is a drilling term indicating the depth of a drill hole at which further penetration is impossible or impractical with equipment being used]

Description	Depth (ft) From	Depth (ft) To
CBW 104		
lat 42°13′ 31″ long 71°08′17″		
Sand, very fine; silt, some	0	19
Sand, very fine; silt; clay, some	19	30
Silt, clay, some	30	125
Gravel	125	126
Refusal	126	
CBW 105		
lat 42°13′24″ long 71°08′12″		
Sand, fine	0	10
Sand, very fine; silt	10	38
Silt; sand, very fine	38	48
Silt; clay, some	48	98
Silt	98	112
Refusal	112	
CBW 106		
lat 42°13′24″ long 71°08′08″		
Sand, medium	0	12
Sand, very fine	12	21
Sand, very fine; silt	21	32
Silt; clay, some	32	98
Sand, medium; silt; gravel, some	98	104
Refusal	104	
CBW 107		
lat 42°13′34″ long 71°08′07″		
Silt	0	35
Silt; clay, some	35	123
Refusal	123	
CBW 108		
lat 42°13′30″ long 71°08′00″		
Sand, medium-fine	0	20
Sand, fine; silt, some	20	36
Silt; clay, some	36	91
Refusal	91	
CBW 109		
lat 42°13′21″ long 71°08′24″		
Sand, medium; gravel	0	12
Sand, medium	12	24
Sand, fine; silt	24	38
Silt; sand, fine to very fine	38	55
Silt; clay, some	55	126.5
Gravel	126.5	127.5
Refusal	127.5	
CBW 110		
lat 42°13′24″ long 71°08′18″		
Silt; sand, very fine	0	12
Silt	12	34
Sand, very fine; silt	34	55
Silt; sand, very fine; clay, some	55	100
Silt; clay	100	127
Till	127	130
Refusal	130	
CBW 111		
lat 42°12′47″ long 71°08′33″		
Sand, very fine	0	20
Sand, very fine; silt, some	20	34
Silt; sand, very fine	34	45
Silt	45	90
Silt; clay, some	90	125
Refusal	125	
CBW 112		
lat 42°13′55″ long 71°07′40″		
Silt; sand, fine	0	10
Silt; clay, some	10	45
Refusal	45	
CBW 113		
lat 42°12′26″ long 71°08′50″		
Sand, very fine; silt	0	12
Sand, medium	12	35
Sand, fine to very fine	35	45
Sand, fine to very fine; silt; clay, some	45	60
Silt; clay, trace	60	119.5
Refusal	119.5	
CBW 114		
lat 42°12′23″ long 71°08′53″		
Sand, medium to fine	0	30
Sand, fine; silt, some	30	43
Sand, fine; silt	43	55
Silt	55	90
Silt; clay, trace	90	120.5
Refusal	120.5	

6. Simulated wells were placed where:

   a. Saturated thickness exceeds 40 ft.

   b. Transmissivity exceeds 3,000 ft^2/d.

   c. Distance between adjacent wells is at least 1,000 ft.

   d. A well can be developed in material with a hydraulic conductivity of 100 ft/d or more.

Maximum pumping rates from wells were determined by simulating constant heads at model nodes where desaturation was limited to 50 percent of the total saturated thickness. To achieve the specified head, the leakage to the cell containing the well was considered equal to the pumping rate for that well for the specified time period. For the well to be of value to a municipality, it had to be able to produce at least 100 gal/min after 180 days. If the well was unable to produce that much water, it was eliminated as a potential well site. Maximum potential pumping rate was determined by the following equation to ensure that desaturation of nodes within the model did not exceed 50 percent of the total saturated thickness, as modified from Trescott and others (1976, p. 10):

$$Q = \pi K \frac{\left(H_w^{\,2} - B^2\right)}{ln\left(\frac{r_e}{r_w}\right)}, \quad (1)$$

where

- Q is the maximum pumping rate that can be sustained assuming 50-percent desaturation of the node,
- K is hydraulic conductivity of the aquifer node where pumping is simulated,
- B is saturated thickness of the node at 50-percent desaturation,
- H_w is saturated thickness to be maintained at the well (this value is a function of well construction and was set at 10 ft above the top of the screen),
- r_e is effective radius of the node in which pumping is simulated (for a square node, r_e is related to width of node (x) by the following approximation: $r_e = \frac{x}{4.8}$), and
- r_w is radius of hypothetical well, which was set to 1 ft.

Results of the aquifer-yield calculations are presented in table 2. Aquifer yields ranged from 2.1 to 12.4 ft^3/s after 30 days of pumping and from 0.3 to 7.1 ft^3/s after 180 days of pumping. After 30 days of pumping, one-half of the aquifer areas had yields of less than 5 ft^3/s, and after 180 days, 6 of 14 aquifer areas had yields of less than 1.8 ft^3/s. For example, if wells were situated to optimally develop the Mill Brook aquifer, yield from storage after 30 days of pumping would be 4 ft^3/s; and after 180 days of pumping, the aquifer yield would decrease to 1.8 ft^3/s. Aquifer yields decreased on a per day basis in all aquifer areas. Yields were related to how the physical and hydraulic factors combined to limit the number and yield of the hypothetical well sites. Aquifer transmissivity and aquifer dimensions (fig. 3) were the critical elements in determining aquifer yield from storage. Greater transmissivity and aquifer dimension increase aquifer yield.

Table 2. Short-term yield from storage for 14 selected aquifer areas, Neponset River Basin, Massachusetts

[Yields are in cubic foot per second]

Aquifer	Pumping period (in days)				
	30	60	90	180	365
Mill Brook	4.0	3.3	2.7	1.8	0.9
Turner Pond	6.0	5.3	4.6	3.1	1.4
Germany Brook	2.4	2.1	1.6	.8	.3
Bird Pond	2.7	1.7	1.2	.6	.3
Traphole Brook	2.1	1.4	.8	.3	.2
School Meadow Brook	5.5	5.0	4.6	3.5	2.0
Neponset Reservoir	3.8	3.2	2.3	1.5	.8
Purgatory Brook	11.0	9.4	7.3	4.1	1.3
White Lodge	9.1	7.0	5.4	3.5	1.5
Reservoir Pond	7.0	7.0	6.0	4.5	2.3
Central Neponset River	12.4	11.1	9.9	7.1	3.6
Beaver Brook	11.5	8.7	7.2	3.6	.9
Steep Hill Brook	4.7	3.3	2.7	1.6	.5
Beaver Meadow Brook	2.7	2.2	1.6	1.0	.4

QUALITY OF GROUND WATER IN THE STRATIFIED-DRIFT AQUIFER AREAS

Ground water in the Neponset River Basin is slightly acidic, is soft to moderately hard, and has relatively low concentrations of dissolved solids. The residence time of ground water in these aquifer areas is short by geologic standards, and the sediments are resistant to chemical reaction; little dissolution of aquifer materials by the ground water occurs. Sodium is the dominant cation, but calcium and iron are commonly present in significant concentrations. Chloride is the most abundant anion. Data on ground-water quality at 16 sampled wells are summarized in table 3. Locations of sample sites are shown in figure 4.

Iron and manganese, which react alike chemically, were present in concentrations that exceeded the U.S. Environmental Protection Agency (USEPA) (1988b) SMCL's of 300 and 50 mg/L, respectively in water from one-half the wells sampled. Many municipalities must treat their water to remove these constituents. Iron and manganese concentrations in the aquifer areas may often be elevated because of mixing with surface water that percolated through a reducing zone in riverbed sediments (Frimpter and Gay, 1979). Ammonia concentrations greater than 1 mg/L in water from these wells (table 4) confirm the presence of reducing environments that can mobilize the iron and manganese.

Chloride and nitrate are constituents that generally indicate contamination by human activities. Concentrations of these constituents have increased since 1940 (Brackley and others, 1973b) but have remained less than the U.S. Environmental Protection Agency (1988a,b) SMCL's of 250 mg/L for chloride and the maximum contaminant level (MCL) of 10 mg/L for nitrate (figs. 5 and 6).

Several public-supply wells have been shut down because the ground water has become contaminated or because of chronic water-quality problems. In 1957, Norwood closed its Buckmaster Pond well and Ellis Avenue well field because of water-quality problems, including the presence of trichloroethelene (TCE). In 1979, public-supply wells also were shut down in Canton and Westwood because of contamination of ground water with TCE. The Canton and Dedham wells have since been returned to operation; contaminants in water from the Dedham wells are removed by use of a water-treatment plant. A School Meadow Brook well has been put on standby use after detection of volatile organic compounds in ground water in 1986.

During this project, water samples were analyzed for 36 volatile organic compounds (table 5) from all aquifer areas. The only compounds detected were trichlorofluoromethane, a refrigerant, in concentrations of 4.0 to 6.2 μg/L in the School Meadow Brook aquifer, and tetrachloroethylene, a solvent, at a concentration of 4.1 μg/L in the Purgatory Brook aquifer.

In addition, land use may preclude the use of parts of aquifer areas or potential aquifer areas for water supply. This is the case for the Traphole Brook aquifer and the Bird Pond aquifer (Interdisciplinary Environmental Science, Inc., 1985).

Table 3. Statistical summary of concentrations of selected physical properties and chemical constituents in water samples from 16 wells in the stratified-drift aquifer areas, Neponset River Basin, Massachusetts

[A total of 32 samples were taken. mg/L, milligram per liter; µg/L, microgram per liter; °C, degree Celsius; µS/cm, microsiemen per centimeter at 25 degrees Celsius; <, actual value is less than value shown]

Property or constituent	Median	Maximum	Minimum
Properties			
Specific conductance (µS/cm)	240	610	125
Dissolved solids, residue at 180°C (mg/L)	155	355	83.0
pH (units)	6.4	6.9	5.4
Major ions, in mg/L			
Calcium, dissolved	14.5	42	7.2
Magnesium, dissolved (µg/L)	4.3	17	2.2
Sodium, dissolved	21.5	44	11
Potassium, dissolved	1.1	3.4	0.0
Alkalinity, total field (as $CaCO_3$)	36	63	14
Sulfate, dissolved	17	32	12
Chloride, dissolved	35	130	15
Fluoride, dissolved	<.10	.20	0
Silica, dissolved (µg/L)	16.5	28	11
Nutrients, in mg/L			
Nitrogen, nitrite, total (as N)	<.01	.36	<.01
Nitrogen, nitrite, dissolved (as N)	<.01	.34	<.01
Nitrogen, nitrite plus nitrate, total (as N)	1.2	4.9	<.10
Nitrogen, ammonia, total (as N)	.07	3.9	<.01
Nitrogen, ammonia plus organic, dissolved (as N)	.40	4.7	.30
Phosphorus, ortho, total (as P)	.02	.15	<.01
Phosphorus, hydrolyzable plus ortho, total (as P)	.02	1.8	<.01
Phosphorus, hydrolyzable plus ortho, dissolved (as P)	.01	.21	.01
Trace elements, in µg/L			
Aluminum, dissolved	20	750	<10
Arsenic, dissolved	<1	20	<1
Boron, dissolved	25	60	20
Iron, dissolved	670	19,000	6
Lead, dissolved	<5.0	19	<5.0
Manganese, dissolved	185	5,300	5
Selenium, dissolved	<1	<1	<1
Zinc, dissolved	21	145	5

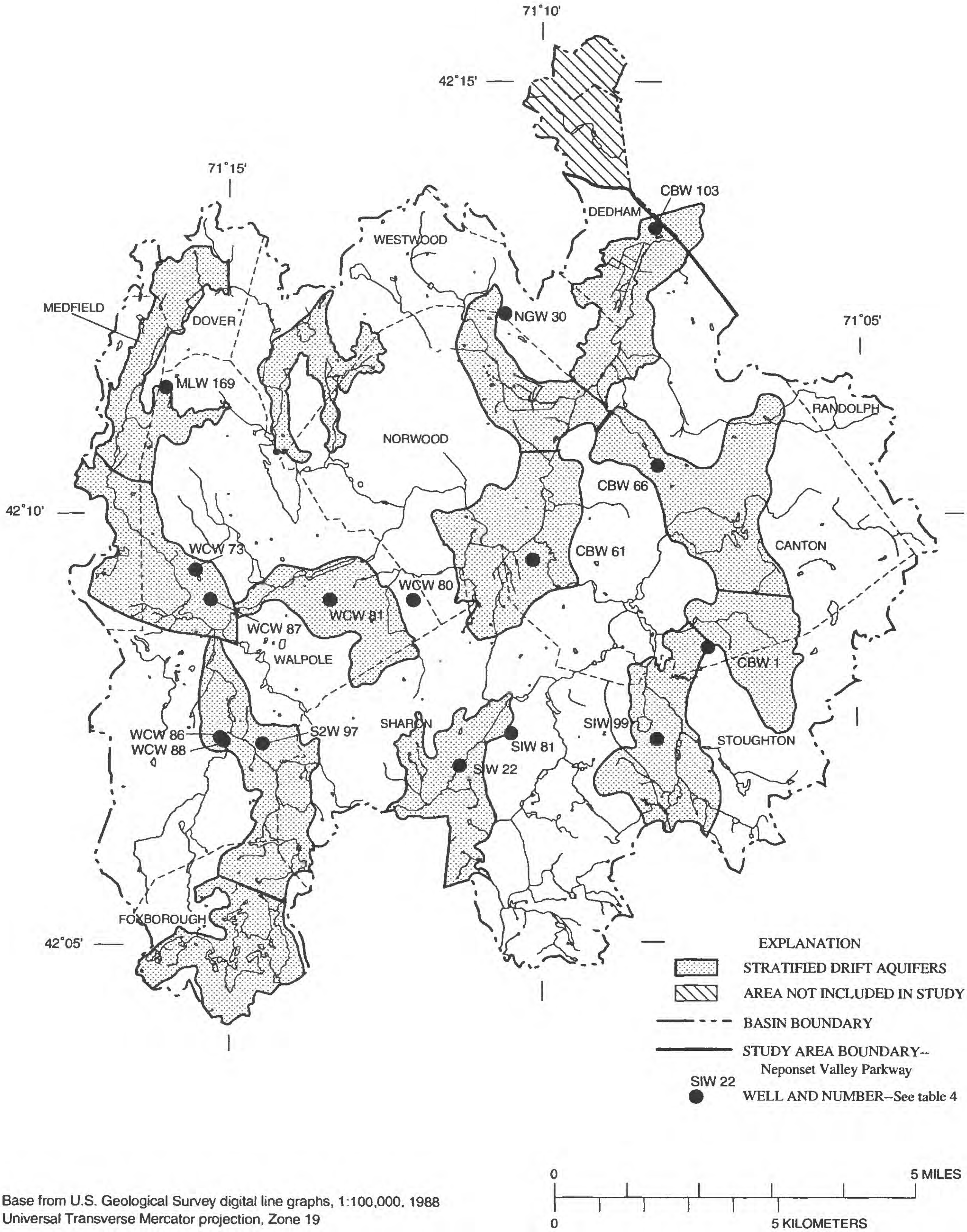


Figure 4. Location of water-quality sampling sites, Neponset River Basin, Massachusetts.

Table 4. Physical properties and concentrations of selected chemical constituents in water from the stratified-drift aquifer areas, Neponset River Basin, Massachusetts

[Location of wells shown in figure 4. All constituents assumed dissolved unless otherwise noted. µS/cm, microsiemen per centimeter at 25 degrees Celsius; mg/L, milligram per liter; °C, degree Celsius; µg/L, microgram per liter; <, actual value is less than value shown]

Well No.	USGS site identification No.	Date	Time	Specific conductance (µS/cm)	pH (standard units)	Calcium, (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)
CBW61	420940071101702	8-25-86	1200	210	6.2	15	4.9	16	0.90
		9-08-87	1200	233	6.2	11	4.4	21	1.0
CBW66	421057071081201	8-25-86	1400	212	6.4	16	3.5	17	1.2
		9-08-87	1400	230	6.4	15	2.9	18	.8
WCW87	420904071153201	8-12-86	0900	125	6.3	8.9	3.7	11	1.1
		9-08-87	0900	140	6.4	10	4.1	14	1.4
WCW73	420931071155701	8-12-86	1100	177	6.1	12	4.0	16	1.2
		9-08-87	1100	202	6.2	13	3.6	23	1.4
S2W99	420740071081701	9-14-86	1200	250	6.5	19	4.6	17	1.1
		9-09-87	1200	235	6.6	17	4.3	19	1.4
S2W97	420733071144601	8-12-86	1130	212	6.3	14	4.8	18	.90
		9-08-87	1130	221	6.4	17	4.6	21	1.2
WCW88	420732071151401	9-04-86	1000	245	6.3	13	4.3	25	.90
		9-08-87	1000	264	6.3	17	4.7	31	1.172
WCW86	420732071151401	9-04-86	1000	245	6.3	13	4.3	25	.90
		9-08-87	1000	264	6.3	17	4.7	31	1.1
MLW169	421151071165301	8-28-86	1000	375	5.9	8.1	2.2	25	0
		9-09-87	1000	405	6.1	8.6	3.5	28	.80
NGW30	421226071105601	9-04-86	0800	610	6.6	42	16	39	1.5
		9-09-87	0800	540	6.7	35	12	36	1.3
CBW103	421330071081601	8-13-86	1200	380	5.8	13	2.6	44	3.4
		9-08-87	1200	360	6.1	16	3.3	37	2.7
WCW80	420927071123001	8-13-86	1000	350	6.9	15	3.4	29	1.3
		9-08-87	1000	385	6.7	18	5.2	25	1.177
WCW81	420930071134201	8-28-86	0800	375	6.3	14	4.2	29	1.4
		9-08-87	0800	398	6.4	17	5.1	26	1.1
SIW22	420709071113301	8-12-86	1300	265	6.4	19	9.0	16	.90
		9-09-87	1300	244	6.6	16	17	22	1.3
SIW81	420752071105101	9-14-86	1000	185	6.6	17	4.4	13	1.0
		9-09-87	1000	205	6.7	14	4.4	20	.80
CBW1	420853071074301	8-25-86	1000	195	6.2	11	3.9	18	1.0
		9-08-87	1000	210	6.4	14	4.3	17	1.178

Well No.	Date	Alkalinity, total field (mg/L as $CaCO_3$)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Solids, residue at 180°C	Nitrogen, nitrite, total (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate, total (mg/L as N)	Nitrogen, ammonia, total (mg/L as N)	Nitrogen, ammonia plus organic (mg/L as N)
CBW61	8-25-86	60	19	24	<0.10	17	124	<0.010	<0.010	2.00	0.040	0.30
	9-08-87	44	24	28	<.10	22	136	<.010	<.010	2.40	.050	.30
CBW66	8-25-86	32	17	31	<.10	13	125	<.010	<.010	.600	.040	.20
	9-08-87	34	12	25	<.10	15	117	<.010	<.010	1.10	.040	.20
WCW87	8-12-86	35	13	15	<.10	18	95	<.010	<.010	<.100	.190	.50
	9-08-87	39	16	17	<.10	21	112	<.010	<.010	<.100	.260	.40
WCW73	8-12-86	32	12	26	<.10	15	113	<.010	<.010	1.40	.090	.40
	9-08-87	38	14	22	<.10	17	83	<.010	<.010	1.70	.130	.5073
S2W99	9-14-86	23	23	59	<.10	24	232	.020	.020	<.100	2.50	2.7
	9-09-87	29	15	48	<.10	19	252	.020	.030	<.100	2.20	3.1
S2W97	9-14-86	32	17	21	<.10	16	155	<.010	<.010	4.90	.050	.40
	9-09-87	37	13	23	<.10	21	205	<.010	<.010	4.60	.040	.50
WCW88	8-12-86	25	13	39	<.10	14	138	<.010	<.010	1.10	.010	.40
	9-08-87	22	17	35	<.10	16	152	<.010	<.010	<.100	.010	.40
WCW86	9-04-86	29	14	40	.10	17	139	<.010	<.010	.600	.050	.20
	9-08-87	33	17	37	.10	21	155	<.010	<.010	.800	1.00	.2074

Table 4. Physical properties and concentrations of selected chemical constituents in water from the stratified-drift aquifer areas, Neponset River Basin, Massachusetts—*Continued*

Well No.	Date	Alkalinity, total field (mg/L as $CaCO_3$)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Solids, residue at 180°C	Nitrogen, nitrite, total (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate, total (mg/L as N)	Nitrogen, ammonia, total (mg/L as N)	Nitrogen, ammonia plus organic (mg/L as N)
MLW169	8-28-86	14	14	38	<0.10	13	121	<0.010	<0.010	1.10	<0.010	<0.20
	9-09-87	24	12	35	<.10	15	132	<.010	<.010	1.70	<.010	<.20
NGW30	9-04-86	44	32	130	.10	15	338	.360	.340	4.20	1.10	1.2
	9-09-87	54	27	90	.10	19	355	.220	.040	3.70	1.60	2.2
CBW103	8-13-86	60	29	78	.20	28	267	.010	<.010	3.30	3.90	4.1
	9-08-87	25	25	92	.20	24	307	.010	<.010	3.90	3.50	4.7
WCW80	8-13-86	27	17	75	<.10	11	195	<.010	<.010	.900	.070	.40
	9-08-87	43	16	86	<.10	14	215	<.010	<.010	1.30	.050	.7079
WCW81	8-28-86	42	20	54	<.10	16	199	<.010	<.010	<.100	1.00	1.8
	9-08-87	49	20	67	<.10	17	212	<.010	<.010	<.100	1.20	1.0
SIW22	8-12-86	50	14	33	<.10	17	155	<.010	<.010	3.70	.030	.60
	9-09-87	45	15	42	<.10	20	166	<.010	<.010	3.10	.030	.90
SIW81	9-14-86	31	17	31	<.10	12	163	.020	<.010	1.60	.140	.50
	9-09-87	43	20	22	<.10	11	185	.020	<.010	2.10	.120	.40
CBW1	8-25-86	55	17	28	<.10	15	119	<.010	<.010	.900	.040	.40
	9-08-87	63	14	31	<.10	12	126	<.010	<.010	.700	.060	.3080

Well No.	Date	Phosphorous, ortho, total (mg/L as P)	Phosphorous hydrolyzable plus ortho, total (mg/L as P)	Phosphorous hydrolyzable plus ortho (mg/L as P)	Aluminum (µg/L)	Arsenic (µg/L)	Boron (µg/L)	Iron (µg/L)	Lead (µg/L)	Manganese (µg/L)	Selenium (µg/L)	Zinc (µg/L)
CBW61	8-25-86	0.020	0.01	0.01	20	<1	30	6	<5	100	<1	12
	9-08-87	.030	.01	.01	40	<1	20	10	<5	160	<1	16
CBW66	8-25-86	<.010	<.01	<.01	30	<1	20	12	<5	10	<1	13
	9-08-87	<.010	<.01	<.01	30	<1	20	10	<5	8	<1	18
WCW87	8-12-86	.100	.08	.07	<10	<1	20	3,000	19	370	<1	86
	9-08-87	.100	.10	.11	10	<1	30	3,500	13	440	<1	74
WCW73	8-12-86	.030	.11	.02	<10	<1	20	1,000	<5	620	<1	5
	9-08-87	.040	.08	.02	10	<1	20	960	<5	660	<1	5
S2W99	9-14-86	.150	1.8	.17	750	2	30	5,300	<5	140	<1	17
	9-09-87	.100	1.2	.21	660	1	20	4,700	<5	140	<1	37
S2W97	9-14-86	.010	.02	.01	20	<1	60	9	<5	8	<1	9
	09-09-87	.010	.02	.01	30	<1	30	22	<5	20	<1	19
WCW88	8-12-86	.020	.02	.02	100	<1	20	29	<5	5	<1	16
	9-08-87	.020	.02	.04	160	<1	20	45	<5	10	<1	5
WCW86	9-04-86	.020	.02	.01	20	<1	30	14	<5	220	<1	21
	9-08-87	.020	.02	.01	20	<1	40	7	<5	280	<1	42
MLW169	8-28-86	<.010	.01	<.01	10	<1	20	22	<5	10	<1	81
	9-09-87	<.010	.01	<.01	20	<1	30	45	<5	30	<1	66
NGW30	9-04-86	<.010	<.01	<.01	10	<1	40	16,000	<5	160	<1	26
	9-08-87	<.010	<.01	<.01	30	<1	30	14,000	<5	210	<1	35
CBW103	8-13-86	.090	.11	.10	590	20	30	10,000	5	250	<1	27
	9-08-87	.120	.08	.16	340	5	40	12,000	8	220	<1	43
WCW80	8-13-86	.020	.03	.01	<10	1	20	6,600	<5	350	<1	21
	9-08-87	.020	.03	.01	10	1	20	7,400	<5	420	<1	42
WCW81	8-28-86	.010	.42	.01	30	<1	30	19,000	<5	5300	<1	60
	9-08-87	.010	.36	.01	20	<1	20	17,000	<5	4400	<1	56
SIW22	8-12-86	.010	.02	.02	<10	<1	20	380	5	160	<1	10
	9-09-87	.010	.02	.08	10	<1	20	340	5	240	<1	11
SIW81	9-14-86	<.010	.01	<.01	10	<1	20	2,900	<5	100	<1	110
	9-09-87	<.010	.01	<.01	20	<1	20	3,500	<5	140	<1	145
CBW1	8-25-86	.010	.01	.01	50	<1	40	160	<5	360	<1	13
	9-08-87	<.010	.01	.01	60	<1	50	150	<5	290	<1	16

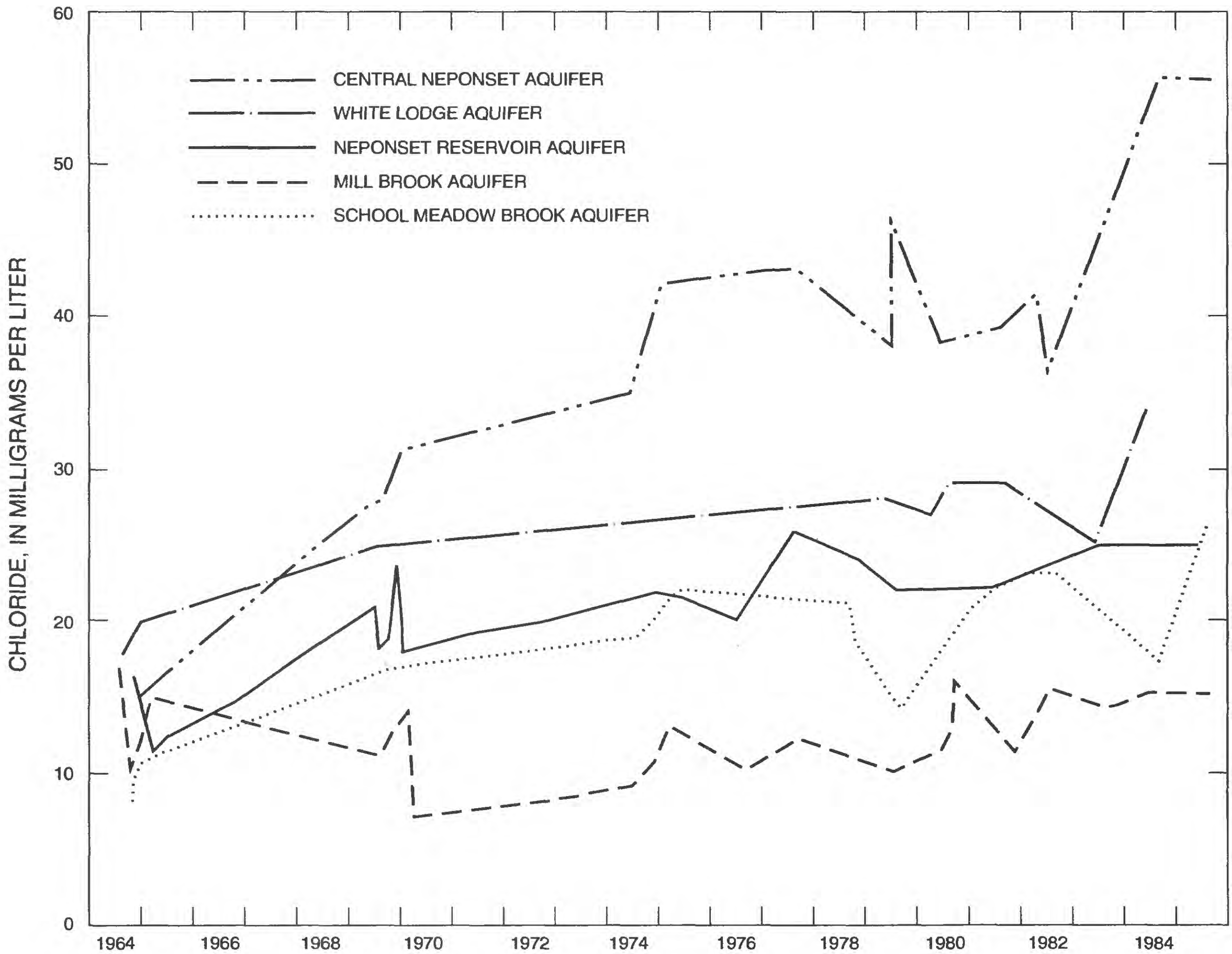


Figure 5. Chloride concentrations at selected wells in the Neponset River Basin, Massachusetts.

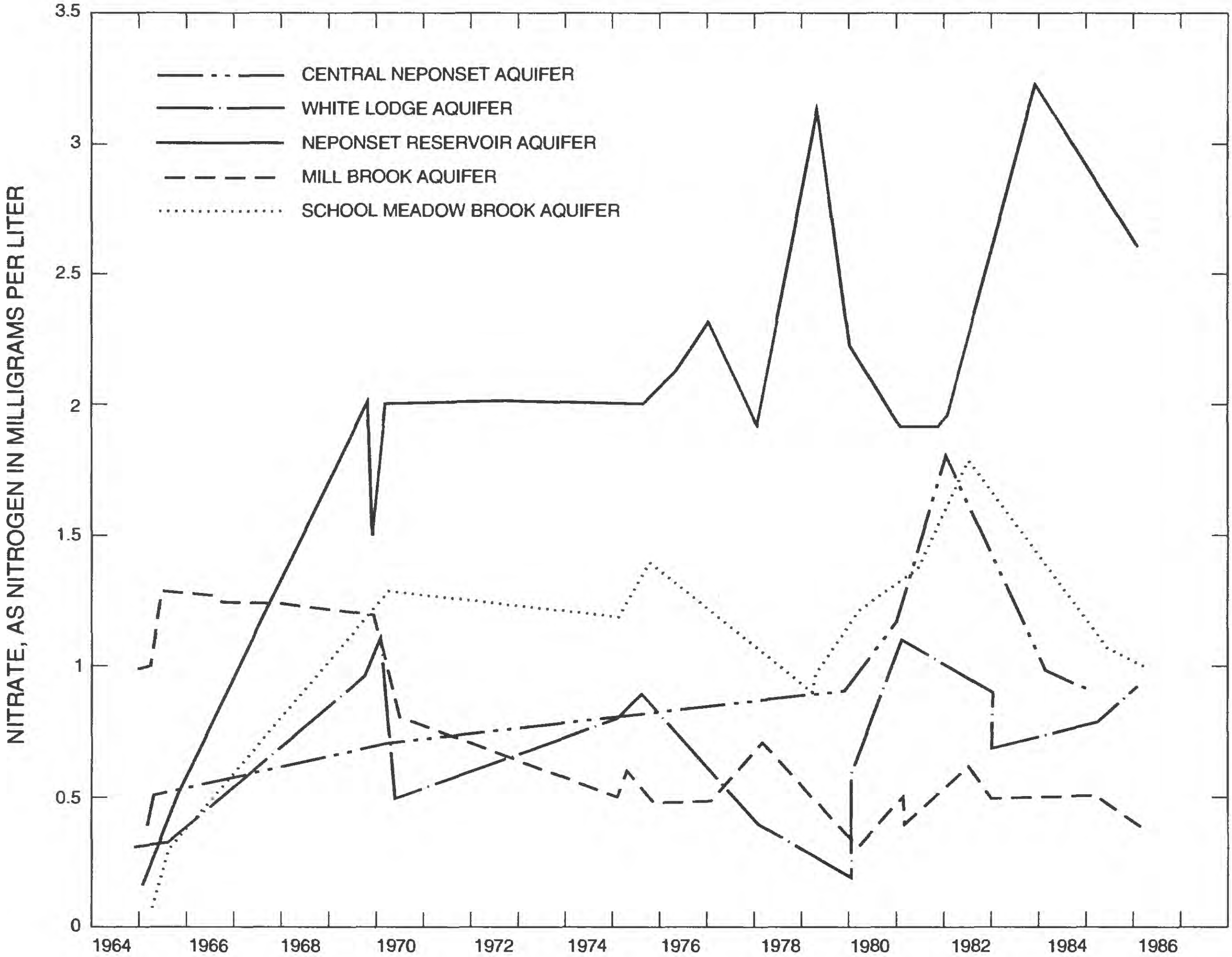


Figure 6. Nitrate concentrations at selected wells in the Neponset River Basin, Massachusetts.

Table 5. Volatile organic compounds analyzed for in water samples from all aquifer areas, Neponset River Basin, Massachusetts

Benzene	1, 2-trans-Dichloroethylene
Bromoform	1, 2-Dichloropropane
Carbon tetrachloride	1, 3-Dichloropropane
Chlorobenzene	eis-1,3-Dichloropropene
Chlorodibromethane	trans-1, 3-Dichloropropene
Chloroethene	Ethylbenzene
1, 1, 2-Chloroethane	Methyl bromide
2-Chloroethyl vinyl ether	Methyl chloride
Chloroform	Methylene chloride
1, 2-Dibromoethylene	Styrene
1, 2-Dichlorbenzene	Tetrachloroethylene
1, 3-Dichlorobenzene	Toluene
1, 4-Dichlorobenzene	1, 1, 1-Trichloroethane
Dichlorobromethane	Trichloroethylene
Dichlorodifluoromethane	Trichlorofluoroethene
1, 1-Dichloroethane	Vinyl chloride
1, 2-Dichloroethylene	Xylene
1, 1-Dichloroethylene	

SUMMARY

This report presents the estimated short-term yields of and the quality of ground water in 14 stratified-drift aquifer areas in the Neponset River Basin. The major aquifer areas in the basin. These aquifer areas are thin and narrow, with saturated thicknesses as much as 130 ft and widths as much as 8,000 ft in some of the bedrock valleys. One stratified-drift deposit, the Fowl Meadow Reservation area, was examined but was considered to be unsuitable for development of municipal water supply on the basis of the criteria used in this study.

Estimates of short-term yields available from aquifer storage for the aquifer areas were made to determine yields available during severe drought. Aquifer yields ranged from 2.1 to 12.4 ft^3/s after 30 days of pumping and from 0.3 to 7.1 ft^3/s after 180 days of pumping.

Ground water in the basin tends to be slightly acidic, of low to moderate hardness, and has relatively low concentrations of dissolved solids. Sodium is the dominant cation and chloride the dominant anion. Iron and manganese concentrations exceeded the USEPA SMCL's of 300 and 50 μg/L in one-half of the wells sampled during this study.

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