DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
RHODE ISLAND WATER RESOURCES BOARD

WATER RESOURCES INVESTIGATIONS 4-74
(SHEET 1 OF 2)

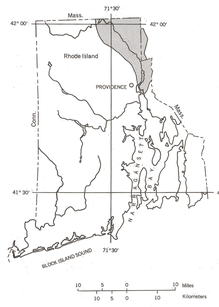

FIGURE 1. — INDEX MAP SHOWING LOCATION OF STUDY AREA (SHADED).

INTRODUCTION

The Blackstone River study area covers 83 square miles of northeastern Rhode Island and 5 square miles of adjacent Massachusetts (fig. 1). It includes parts of the Blackstone, Moshassuck, and Tenmile River basins, and a coastal area that drains to the brackish Seekonk and Providence Rivers. In Rhode Island, all or parts of the suburban towns of Cumberland, Lincoln, North Smithfield, and Smithfield and all or parts of the cities of Central Falls, East Providence, Pawtucket, Providence, and Woonsocket are within the study area. Also included are parts of the towns of Attleboro and North Attleborough in Massachusetts. In 1970, total population was about 240,000, which was equivalent to about one-fourth of the total population of Rhode Island. Fresh water usage in 1970 by public-supply systems and self-supplied industry was about 33 mgd (million gallons per day), which was equal to 22 percent of total fresh water use in Rhode Island for all purposes except generation of electric power (fig. 2). Anticipated increases in population and per capita water requirements are likely to cause the demand for water to more than double within the next 50 years. A significant part of this demand can be met from wells that tap the principal stratified-drift aquifer, which occupies the valleys of principal streams. This aquifer yielded an average of 10 mgd in 1970 and is capable of sustaining a much higher yield.

The primary objectives of the study were to determine and map the saturated thickness and transmissivity of the stratified-drift aquifer and to assess the potential sustained yield of those parts of the aquifer favorable for large-scale development of water. A secondary objective was to describe ground-water quality and to evaluate the impact of induced infiltration of polluted stream water on the quality of native ground water.

This report is based on analysis of drillers' records of more than 700 wells and borings which include 462 lithologic logs; 35 specific-capacity determinations; 12 aquifer tests, including detailed tests at two sites to determine streambed infiltration rates; chemical analyses of 92 ground-water and 15 stream-water samples; and geologic mapping. Selected basic data are published in a separate report (Johnston and Dickerman, in press).

The authors are indebted to well drillers, especially American Drilling and Boring Company, R.E. Chapman Company, and Layne New England Company, for making their records available; to the water departments of the towns of Cumberland and Lincoln, for allowing aquifer tests of their well fields; to the Rhode Island Department of Health, for providing data on water quality and use; and to many other federal, state, and municipal agencies, companies, and individuals who supplied information. Their contributions are gratefully acknowledged.

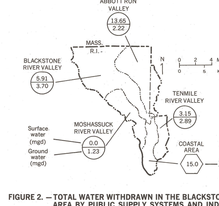

FIGURE 2. — TOTAL WATER WITHDRAWN IN THE BLACKSTONE RIVER AREA BY PUBLIC SUPPLY SYSTEMS AND INDUSTRY IN 1970 WAS 47.7 MGD (MILLION GALLONS PER DAY), CONSISTING OF 22.7 MGD FRESH SURFACE WATER, 10.0 MGD FRESH GROUND WATER, AND 15.0 MGD SALINE SURFACE WATER. Public supply systems account for 96 percent of the fresh surface water and 75 percent of the fresh ground water withdrawn in the study area. All saline surface water was withdrawn from the Seekonk River to cool condensers used in generating electric power.

BEDROCK AND TILL AQUIFERS

Bedrock, consisting of igneous, metamorphic, and highly consolidated sedimentary rocks, underlies the entire study area. Till, typically 10 to 20 feet thick, mantles the bedrock in upland areas and commonly occurs in the valleys at the base of the stratified-drift aquifer. Several billion gallons of water is stored in intergranular voids in till and in open fractures in the upper few hundred feet of bedrock. Yields of wells that tap these aquifers are typically between 2 and 15 gpm (gallons per minute), as determined by short-term (generally 1/2 to 2 hours) tests. A few deep (200 to 700 feet) wells that tap sedimentary bedrock below 30 to 100 feet of stratified drift yield 50 to 150 gpm. Sedimentary bedrock, chiefly conglomerate, sandstone, and shale, underlies the stratified-drift aquifer in the Tenmile River valley, the Coastal area, and most of the Moshassuck River and Abbott Run valleys.

The till is an unreliable source of water to wells in many places. Wells on steep slopes and hillsides commonly go dry during droughts. Moreover, shallow wells constructed in till are highly susceptible to contamination by effluent from nearby septic tanks and cesspools.

Wells 50 to 250 feet deep in the bedrock aquifer will usually yield supplies of 500 to 1,000 gpd (gallons per day), which are more than adequate for single family dwellings. Continuous yields of 10,000 to 50,000 gpd, which are adequate for small industrial needs, are obtainable from some wells that penetrate from 100 to 600 feet of sedimentary bedrock in those areas where it is mantled by the stratified-drift aquifer.

STRATIFIED-DRIFT AQUIFER

The stratified-drift aquifer, which covers 34 square miles of the study area, partly or completely fills narrow channels cut into the bedrock surface by preglacial streams. The axes of these channels are approximately defined by zones of maximum saturated thickness. Except in Cherry Run valley, parts of Abbott Run Valley, and much of the western part of Tenmile River valley, the aquifer has been extensively explored by test drilling. The aquifer is composed of interstratified lenses of gravel, sand, silt, and clay, few of which appear to extend laterally more than a few hundred feet. Permeable lenses of medium to coarse sand and gravel are common, but at what depth, if at all, a well drilled at any particular site will penetrate coarse material is difficult to predict. Fine sand, silt, and clay are abundant in the stratified-drift aquifer in the Moshassuck and Tenmile River valleys, in places comprising the entire saturated zone.

The transmissivity of the aquifer was determined by analysis of specific-capacity data and aquifer tests, and from estimates based on lithologic logs. Specific yield was estimated from data given by Johnson (1967). The average specific yield of the aquifer is probably between 0.20 and 0.30.

Water occurs in the aquifer under water-table conditions and is in good hydraulic connection with overlying streams, ponds, and reservoirs.

RECHARGE TO THE STRATIFIED-DRIFT AQUIFER

Recharge to the stratified-drift aquifer results from (1) infiltration of precipitation and percolation to the water table, (2) subsurface inflow from adjacent till and bedrock in which the water table is at a higher altitude, and (3) infiltration induced from streams and other bodies of surface water.

Recharge from precipitation is estimated to average 1 mgd per square mile, except in the urbanized Moshassuck River and Tenmile River valleys, where the estimate is reduced to 0.7 mgd per square mile, because as much as 30 percent of the aquifer surface is covered by roads, buildings, and other impervious surfaces. The rate of 1 mgd per square mile is consistent with results of studies in eastern Connecticut and Long Island, N.Y. In eastern Connecticut, where precipitation and runoff are about the same as in the study area, average annual ground-water runoff (a partial measure of average annual recharge) from stratified drift is 1 mgd per square mile (Randall and others, 1966, p. 66). Ground-water runoff constitutes 95 percent of total runoff from stratified glacial drift under similar climatic conditions on Long Island (Pluhowski and Kantrowitz, 1964, p. 35). Application of the same percentage to average annual runoff of 1.1 mgd per square mile (23 inches) measured in the study area indicates that ground-water runoff from (and therefore recharge to) the stratified-drift aquifer averages at least 1 mgd per square mile.

Recharge by subsurface inflow from till and bedrock is continuous and is estimated to average 0.004 and 0.017 mgd, respectively, per 1,000 feet of aquifer perimeter. These rates were determined by a modified form of the Darcy equation, Q = TIL; where T is transmissivity, in feet squared per day (ft^2/d); I is hydraulic gradient, in feet per foot; and L is length of the section through which flow occurs, in feet. The average transmissivity of bedrock obtained from analysis of specific-capacity data for 247 bedrock wells in eastern Connecticut is 33 ft^2/d (Randall and others, 1966, p. 63). Because the depths and yields of bedrock wells in eastern Connecticut are about the same as depths and yields of bedrock wells in the study area, bedrock transmissivity is assumed to be the same in both areas. Average transmissivity of the till is estimated to be 8 ft^2/d. This value is the product of saturated thickness of the till, which averages about 8 feet, and an assumed hydraulic conductivity of 1 foot per day. The average hydraulic gradient in till and bedrock is estimated to be 0.07 foot per foot from measurements of maximum water-table slopes in the vicinity of several wells that tap bedrock and till near the perimeter of the stratified-drift aquifer.

Recharge induced from streams is the principal source of water to most heavily pumped wells in the study area. Recharge is induced when the normal water-table slope toward a stream (fig. 3A) is reversed by pumping and the water table at the stream is lowered below the stream surface (fig. 3B). The rate at which infiltration is induced is dependent upon several factors, among which the vertical hydraulic conductivity of the aquifer and streambed, the hydraulic gradient established between the stream and the well, and the area and depth of the stream are of principal importance.

Leakage, or infiltration, rates of the bed of the Blackstone River were determined at Manville and Quinnville (Areas B and D). The array of shallow (12 to 25 feet) well points used to measure the configuration of the cone of pumping influence in the vicinity of two municipal wells, owned by the town of Lincoln, at Quinnville is shown. Infiltration rates of 0.05 and 0.58 mgd per acre per foot of head loss were determined at Manville and Quinnville, respectively. An infiltration rate of at least 0.5 mgd per acre per foot is indicated for the Moshassuck River, on the basis of a streamflow loss of 0.61 mgd over a reach of the river 17,500 feet long, measured on September 31, 1971, at a time when average depth and width of the river were 0.3 and 10 feet, respectively. Because streambeds consist of coarse sand and gravel virtually everywhere in the study area, it is likely that vertical hydraulic conductivity of the aquifer is the dominant factor controlling induced infiltration rates. For purposes of modeling, a maximum infiltration rate of 0.1 mgd per acre per foot of head was assumed.

The percentage of pumpage diverted from streamflow is governed by the hydraulic characteristics of the aquifer, the distance between the well and the source of recharge, and the duration of pumping (fig. 4). Under conditions of sustained pumping, most wells close to streams derive virtually all of their water from streamflow and cause very little depletion of ground-water storage (fig. 5).

GLOSSARY

AQUIFER: A formation, group of formations, or part of a formation that contains enough saturated permeable material to yield significant quantities of water to wells and springs.

DRAWDOWN: The difference between nonpumping and pumping water level in a well.

GROUND-WATER RESERVOIR: Parts of the stratified-drift aquifer where ground water is accumulated under conditions that make it suitable for development and use.

HYDRAULIC CONDUCTIVITY: The volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. Expressed herein in feet per day. These values may be converted to gallons per day per square foot by multiplying by 7.48.

HYDRAULIC GRADIENT: The change in static head per unit of distance in the direction of the maximum rate of decrease in head. It is the slope of the water table.

SATURATED THICKNESS: The thickness of an aquifer below the water table. As measured for the stratified-drift aquifer in this report, it is the vertical distance between the water table and the bedrock surface and in places includes till present between the stratified drift and the bedrock surface.

SPECIFIC YIELD: The ratio of the volume of water that a fully saturated rock or unconsolidated material will yield by gravity drainage, given sufficient time, to the total volume of rock or unconsolidated material; commonly expressed as a percentage.

STRATIFIED DRIFT: Unconsolidated sediment that has been sorted by glacial meltwater and deposited in layers, or strata.

TILL: Predominantly nonsorted, nonstratified, unconsolidated sediment deposited directly from glaciers.

TRANSMISSIVITY: The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of aquifer under a unit hydraulic gradient. It is equal to the product of hydraulic conductivity and saturated thickness. Expressed herein in cubic feet per day per foot or, more simply, feet squared per day. These values may be converted to gallons per day per foot by multiplying them by 7.48.

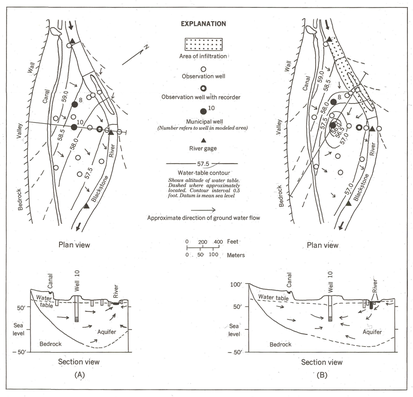

FIGURE 3. — (A) QUINNVILLE WELL FIELD (AREA D) ON APRIL 22, 1971, PRIOR TO START OF AQUIFER TEST, SHOWING THE NATURAL FLOW OF WATER FROM THE AQUIFER INTO THE BLACKSTONE RIVER. (B) QUINNVILLE WELL FIELD ON APRIL 24, 1971, AFTER 48 HOURS OF CONTINUOUS PUMPING FROM WELL 10, SHOWING MOVEMENT OF WATER FROM THE BLACKSTONE RIVER INTO THE AQUIFER AND TOWARD THE WELL. An infiltration rate was determined from the following equation:

$$I_r = \frac{Q P_r}{A s} = \frac{0.89 \times 0.58}{2.77 \times 0.32} = 0.58 \text{ mgd per acre per ft of head loss}$$

where: I_r = infiltration rate, in mgd per acre per foot of head loss.
Q = Pumping rate, in mgd.
P_r = Percentage of water being diverted from river (After method by Theis, in Walton, 1962).
A = Streambed area of infiltration, in acres.
s = Average head loss within streambed area of infiltration, in feet.

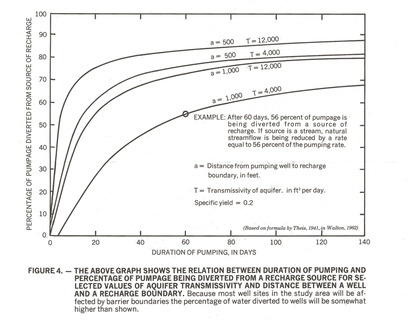

FIGURE 4. — THE ABOVE GRAPH SHOWS THE RELATION BETWEEN DURATION OF PUMPING AND PERCENTAGE OF PUMPAGE BEING DIVERTED FROM A RECHARGE SOURCE FOR SELECTED VALUES OF AQUIFER TRANSMISSIVITY AND DISTANCE BETWEEN A WELL AND A RECHARGE BOUNDARY. Because most well sites in the study area will be affected by barrier boundaries the percentage of water diverted to wells will be somewhat higher than shown.

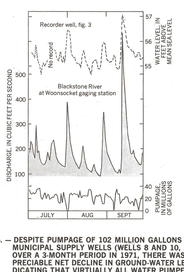

FIGURE 5. — DESPITE PUMPAGE OF 102 MILLION GALLONS FROM 2 MUNICIPAL SUPPLY WELLS (WELLS 8 AND 10, AREA D) OVER A 3-MONTH PERIOD IN 1971, THERE WAS NO APPRECIABLE NET DECLINE IN GROUND-WATER LEVEL INDICATING THAT VIRTUALLY ALL WATER PUMPED FROM THE AQUIFER WAS REPLENISHED BY INFILTRATION OF RIVER WATER. The similarity of the river discharge and ground-water level hydrographs shows that river level, rather than pumping, exercises the dominant control over the ground-water level.

METHOD USED TO ESTIMATE POTENTIAL YIELD OF THE STRATIFIED-DRIFT AQUIFER

Parts of the stratified-drift aquifer identified by letter symbols A through H on the geohydrologic map were analyzed as model aquifers in which the barrier-boundary effects of irregular bedrock valley walls and the recharge-boundary effects of meandering streams were assumed to be linear. The potential yield of selected schemes of real and hypothetical wells within the areas modeled were then determined for assumed periods of pumping. (See summary table for each area.)

Computations of yield and drawdown were made by digital computer and are based on the Theis nonequilibrium equation and image-well theory (Ferris and others, 1962). Drawdowns in pumping wells were adjusted for the effects of aquifer dewatering, partial penetration of the well by the well screen, and well-entrance losses by methods described by Walton (1962). The yields shown in the summary tables are computed for pumping levels no lower than the tops of the well screens. Different potential yields computed for given wells result chiefly from variations in interference effects caused by pumping different combinations of wells. Hypothetical wells are assumed to have a radius of 1 foot. A specific yield of 0.15 is assumed for the model of area G; a value of 0.20 is assumed for all others.

Simulated pumpage is assumed to be from aquifer storage and induced stream infiltration. Computations of induced infiltration are based on typical stream depths at low flow. Although sustained pumping from wells in most parts of the stratified-drift aquifer will cause recharge to be induced from streams, conditions of no recharge are assumed in three areas (F, G, and H) to demonstrate the capacity of the aquifer to yield water from storage.

Short-term aquifer-test data, largely unaffected by pumping from other wells, are given in the summary tables for wells. These data may be compared with results obtained by model analysis for long-term (100 to 200 days) periods of pumping from combination of wells.

Pumping is simulated from different combinations of real and hypothetical wells to illustrate the effect of well spacing. Spacing wells too closely results in mutual well interference, reduction in yield of individual wells, and may introduce only a small increase in total yield. Spacing wells too far apart results in a smaller total yield than is obtainable.

Yields computed for pumping periods of 100 days give an indication of peak pumping capacity during dry summer months. Yields computed for pumping periods of 200 days indicate pumping capacity under conditions similar to those that prevail in the study area during extended droughts. Withdrawal rates equal to the 200-day yields can be sustained indefinitely, provided the surface inflow to the stratified-drift aquifer is not decreased appreciably. Computed withdrawal rates are smaller than the average annual rate of recharge from precipitation and subsurface inflow and the potential rate of recharge from induced stream infiltration.

Parts of the aquifer from which most of the water pumped is recharged by induced infiltration are modeled as linear-strip aquifers bounded on one side by a barrier boundary and on the other by a recharge boundary. The position of the recharge boundary for a given pumping rate is determined by a modification of an iterative method described by Schicht (1965, p. 49). For a given pumping rate and recharge boundary position, drawdown is computed at points within several stream reaches to which an average length, width, water depth, and streambed infiltration rate are assigned. Infiltration resulting within each stream reach is calculated and summed. The position of the recharge boundary is shifted until the pumping rate is approximately balanced by the rate of infiltration.

The validity of the model aquifers was checked, where aquifer-test data are available, by comparing real and computed drawdowns in observation wells. Good agreement is obtained in most instances, indicating that model boundaries and aquifer properties are correctly simulated.

The potential yield of an individual well in any part of the stratified-drift aquifer can be estimated using table 1.

ABBOTT RUN VALLEY

(Area F)

Runoff from the entire drainage area (27.8 square miles) of Abbott Run is utilized by the Pawtucket municipal water supply system. Two surface reservoirs having a combined storage capacity of 3.78 billion gallons capture runoff from an area of 18.9 square miles upstream from Arnold Mills. Water is released from them as needed to Abbott Run and is withdrawn at a treatment plant at Happy Hollow Pond. Part of the released water is withdrawn by municipal wells (wells 2, 3, 4, 7, 9, 11, 12, and 13 in the model aquifer), which induce infiltration from Happy Hollow and Robin Hollow Ponds. An average of 15.88 mgd was withdrawn by the Pawtucket system in 1970, of which 2.23 mgd was obtained from wells.

Downstream from the surface reservoirs, the stratified-drift aquifer covers 4.5 square miles and has a saturated thickness of as much as 80 feet. Saturated volume of the aquifer is about 4 billion cubic feet, of which about 20 percent (6 billion gallons), is water in storage. Perhaps as much as one-third of the water in storage can be withdrawn by wells.

Natural recharge to the stratified-drift aquifer, exclusive of undetermined subsurface inflow beneath the reservoir at Arnold Mills, is estimated to average 5.8 mgd, or 2.1 billion gallons annually. This estimate includes relatively constant subsurface inflow of 1.3 mgd from till and bedrock and precipitation recharge of 4.5 mgd. Streamflow measurements made June 21, 1971, when nearby gaged streams were at flows equaled or exceeded about 70 percent of the time, indicated ground-water discharge to Abbott Run at a rate of 3.9 mgd between Sneech Pond Road in Cumberland, R.I., and Mendon Road in North Attleborough, Mass. This indicates that natural discharge from, and therefore natural recharge to, the ground-water reservoir is 3.9 mgd or more about 70 percent of the time.

Induced recharge potentially available from Abbott Run is on the order of 17 mgd, assuming the water table is lowered beneath the streambed, the streambed infiltration rate is 0.05 mgd per acre per foot of head, and the surface reservoir releases are adequate to maintain an average stream depth of 3 feet.

The potential yield of the ground-water reservoir is significantly affected by the amount of induced recharge available from Abbott Run. The table below shows, for example, that 12 mgd can be pumped for 200 days from a scheme of 21 wells, provided adequate stream depth is maintained, but that only 5 mgd can be pumped for 200 days from the same scheme of wells if no recharge is available from Abbott Run. If water were to be piped directly from the surface reservoirs to the treatment plant, the ground-water reservoir could sustain a yield equal to natural recharge of 5.8 mgd plus whatever reservoir releases are available for infiltration.

Raising the spillway elevation of the dam on Robin Hollow Pond has been proposed as a means of increasing the dependable yield of the Pawtucket system. The table below shows that increasing the elevation by 7 feet will also increase the potential yield of wells by as much as 2 mgd by increasing the rate at which infiltration will be induced.

Virtually all the runoff from the basin is pumped into the Pawtucket municipal supply system during very dry years. Thus, any water exported from the basin by users other than the city of Pawtucket during dry years, whether directly from Abbott Run or from wells, will reduce the dependable supply of the Pawtucket system.

TABLE 9. — SUMMARY OF POTENTIAL YIELD FOR AREA F

Well number in modeled area	Aquifer test: Yield (mgd)	Aquifer test: Drawdown (ft)	Aquifer test: Duration (days)	Available drawdown above screen (ft)	Transmissivity near well (ft^2 per day)	Potential yield for indicated period and well combinations assuming withdrawals are from storage (S) or storage and river infiltration (S + RI): (S + RI) 200 days	(S + RI) 100 days	(S) 100 days
2	1.0	21	1.0	37	13,000	0.8	1.0	0.7
3	1.0	18	1.0	49	13,000	1.0	1.3	.8
4	1.4	9	.4	27	13,000	.5	.7	.4
7	1.0	23	1.7	36	13,000	.9	1.1	.8
9	1.1	28	—	35	13,000	.7	1.0	.7
11	1.3	17	—	26	13,000	.4	.6	.3
12	1.7	20	—	50	13,000	1.0	1.4	.9
13	1.5	29	6.7	40	13,000	.7	.9	.6
15	—	—	—	30	13,000	—	—	.7
17	—	—	—	30	13,000	—	—	.8
19	.4	9	7.0	15	13,000	.5	—	.4
22	—	—	—	30	5,000	—	—	.3
24	—	—	—	30	5,000	—	—	.3
26	—	—	—	30	5,000	—	—	.3
28	.6[a]	52[b]	2.1	62	13,000	1.3	—	1.3
31	—	—	—	30	5,000	—	—	.3
33	—	—	—	30	5,000	—	—	.3
34	.7[a]	28[b]	1.1	38	13,000	.9	—	.8
35	.5[a]	28[b]	1.1	31	13,000	.8	—	.7
37	—	—	—	30	5,000	—	—	.3
39	—	—	—	30	5,000	—	—	.3
					TOTAL	9.5	8.0[c]	12.0

Well number in modeled area	Potential yield for 200 days (S)	(S + RI)	(S + RI)
2	0.7	0.5	0.3
3	.8	.5	.3
4	.4	.2	.1
7	.8	.4	.2
9	.7	.3	.2
11	.3	.1	.1
12	.9	.6	.4
13	.6	.3	.2
15	.7	.4	.2
17	.8	.5	.4
19	.4	.2	.1
22	—	.3	.2
24	—	.3	.2
26	—	.3	.2
28	1.3	1.0	.8
31	—	.3	.2
33	—	.3	.2
34	.8	.6	.4
35	.7	.4	.3
37	—	.3	.2
39	—	.3	.2
	12.0	7.5	5.0

a/ Yield can be improved if entrance losses are reduced.
b/ Substantial part of drawdown caused by well entrance losses.
c/ Assumes Robin Hollow Pond raised 7 feet.

TABLE 1. — POTENTIAL YIELD OF WELLS FOR SELECTED COMBINATIONS AQUIFER TRANSMISSIVITY AND SATURATED THICKNESS

Saturated thickness (ft)	Transmissivity (ft^2 per day): 0 – 4,000	4,000 – 8,000	8,000 – 12,000	>= 12,000
	Well yield[1] (gpm)			
10 – 40	0 – 150	30 – 250	75 – 450	100 – 1,000
40 – 80	0 – 200	200 – 500	300 – 900	500 – 1,200
80 – 120	0 – 400	300 – 800	500 – 1,000	800 – 1,400
>= 120	0 – 600	400 – 1,000	800 – 1,200	1,000 – 1,600

[1]Assuming: (1) well has a radius of 1 foot, is 90 percent efficient, and is screened in the lower one-third of the saturated zone; (2) specific yield is 0.20; and (3) duration of pumping is 200 days.

THE ABOVE TABLE MAY BE USED TO ESTIMATE THE POTENTIAL YIELD OF CAREFULLY CONSTRUCTED AND DEVELOPED WELLS LOCATED BY EXPLORATORY TEST DRILLING. In areas where a substantial part of the saturated zone is composed of silt and clay, potential yield will be governed by the maximum depth to beds of permeable sand and gravel

BLACKSTONE RIVER VALLEY

(Areas A to E inclusive)

The lithologic and hydraulic characteristics of the stratified-drift aquifer in the Blackstone River valley are known from drillers' logs of 170 wells and borings and from aquifer-test and specific-capacity data at 19 sites.

From the Massachusetts line to Ashton the aquifer is very narrow and averages 40 feet thick or more over an average width of less than 500 feet. Much of the thickest and most transmissive part of the aquifer is beneath the river. Nevertheless, yields of 0.3 mgd (208 gpm) or more are obtainable at many sites from carefully constructed, efficient wells placed close to the river. The maximum known thickness and transmissivity of the aquifer in this part of the river valley are 70 feet and 17,600 ft^2/d, respectively.

From Ashton to Valley Falls Pond the aquifer has a maximum known thickness and transmissivity of 165 feet and 44,000 ft^2/d, respectively. The saturated volume of about 4 billion cubic feet is estimated to contain 6 billion gallons of water.

The potential yield of the stratified-drift aquifer in the Blackstone River valley is governed largely by the rate at which infiltration can be induced from the river. The amount of river discharge that can be diverted into the aquifer is dependent upon the number and location of wells, the hydraulic characteristics of the aquifer, the infiltration rates of the riverbed and other factors. River discharge at all times is greater than can be diverted to wells. The discharge at Woonsocket averages 458 mgd (1929-71), or 3 times greater than the rate of fresh-water use in Rhode Island in 1970, and is equal to or greater than 65 mgd 98 percent of the time.

Simulated withdrawals from model aquifers in areas A through E indicate that as much as 30 mgd can be obtained from a relatively small number of wells. Additional amounts can be obtained from less favorable areas not modeled.

TABLE 2. — SUMMARY OF POTENTIAL YIELD FOR AREA A

Well number in modeled area	Aquifer test: Yield (mgd)	Aquifer test: Drawdown (ft)	Aquifer test: Duration (days)	Available drawdown above screen (ft)	Transmissivity near well (ft^2 per day)	Potential yield for 200 days for indicated well combinations (mgd)
7	—	—	—	33	5,000	0.4
8	—	—	—	33	5,000	.4
15	—	—	—	30	10,000	.7
17	0.9	20	1.0	30	10,000	.7
29	—	—	—	35	10,000	.9
31	.8	27	3.0	30	7,000	.5
42	1.7	20	16.0	23	17,000	1.0
47	.5	12	8.1	17	8,000	.4
					TOTAL	5.0

TABLE 3. — SUMMARY OF POTENTIAL YIELD FOR AREA B

Well number in modeled area	Aquifer test: Yield (mgd)	Aquifer test: Drawdown (ft)	Aquifer test: Duration (days)	Available drawdown above screen (ft)	Transmissivity near well (ft^2 per day)	Potential yield for 200 days for indicated well combinations (mgd)		
5	1.0	10	2.0	34	12,000	—	0.5	0.4
6	.9	—	—	33	12,000	1.0	.8	.6
7	—	—	—	33	12,000	—	—	.6
9	1.5	34	2.0	48	12,000	1.1	1.1	1.0
10	.5	6.6	3.8	30	12,000	—	—	.7
14	—	—	—	45	10,000	—	1.0	1.0
					TOTAL	2.1	2.4	3.6

Well number in modeled area	Potential yield for 200 days for indicated well combinations (mgd)
5	3.9
6	1.0
7	—
9	1.0
10	.8
14	—
	6.8

TABLE 4. — SUMMARY OF POTENTIAL YIELD FOR AREA C

Well number in modeled area	Aquifer test: Yield (mgd)	Aquifer test: Drawdown (ft)	Aquifer test: Duration (days)	Available drawdown above screen (ft)	Transmissivity near well (ft^2 per day)	Potential yield for indicated period and well combinations (mgd) 100 days	200 days
5	0.8	9	1.2	28	14,000	0.6	0.4
6	.9	10	1.2	37	14,000	.6	.4
9	—	—	—	30	14,000	—	.7
11	—	—	—	30	14,000	—	.8
12	.7	9.5	1.1	24	11,000	.5	.1
13	—	—	—	40	11,000	—	.8
16	1.6	32	1.1	60	14,000	1.2	1.0
17	.4	18	1.1	60	14,000	1.4	1.3
20	—	—	—	45	14,000	—	1.3
					TOTAL	4.3	6.8

TABLE 5. — SUMMARY OF POTENTIAL YIELD FOR AREA D

Well number in modeled area	Aquifer test: Yield (mgd)	Aquifer test: Drawdown (ft)	Aquifer test: Duration (days)	Available drawdown above screen (ft)	Transmissivity near well (ft^2 per day)	Potential yield for indicated period and well combinations (mgd) 100 days	200 days
8	1.4	8.3	2.0	41	40,000	2.9	2.5	2.3
10	1.4	8.0	2.0	29	40,000	1.9	1.5	1.1
12	—	—	—	30	40,000	—	—	1.2
14	—	—	—	30	40,000	—	2.0	1.7
					TOTAL	4.8	6.0	6.3

TABLE 6. — SUMMARY OF POTENTIAL YIELD FOR AREA E

Well number in modeled area	Aquifer test: Yield (mgd)	Aquifer test: Drawdown (ft)	Aquifer test: Duration (days)	Available drawdown above screen (ft)	Transmissivity near well (ft^2 per day)	Potential yield for 200 days for indicated well combinations (mgd)
6	0.6	32	1.2	47	6,000	0.3
11	—	—	—	80	10,000	—
13	—	—	—	80	10,000	—
15	—	—	—	80	14,000	—
16	—	—	—	80	18,000	3.0
22[a]	2.0	49	3.4	110	21,000	2.7
					TOTAL	6.0

Well number in modeled area	Potential yield for 200 days for indicated well combinations (mgd)
6	—
11	1.2
13	1.3
15	1.6
16	2.0
22[a]	2.7
	8.8

a/ Not included in model. Potential yield based on 1955 pumpage of 549 million gallons.

TABLE 7. — SUMMARY OF POTENTIAL YIELD FOR AREA G

Well number in modeled area	Aquifer test: Yield (mgd)	Aquifer test: Drawdown (ft)	Aquifer test: Duration (days)	Available drawdown above screen (ft)	Transmissivity near well (ft^2 per day)	Potential yield for indicated period and well combinations assuming withdrawal is from aquifer storage: 100 days (S)	100 days (S + RI)	200 days (S)	200 days (S + RI)
2	—	—	—	75	8,000	0.6	0.6	—	0.4
3	0.2	34	0.2	100	11,000	—	.7	—	.4
4	1.5	26	.2	57	19,500	.6	.4	0.8	.3
5	—	—	—	105	8,000	.8	.5	—	.3
6	—	—	—	105	8,000	—	.4	—	.3
7	—	—	—	105	8,000	—	.4	—	.3
8	—	—	—	105	8,000	.7	.5	—	.3
9	.2	6.2	.6	62	5,000	—	.2	—	.1
10	1.5	54	3.3	68	22,300	.5	.3	.7	.3
11	—	—	—	75	12,000	.7	.6	—	.5
12	—	—	—	60	10,000	—	.4	—	.2
13	—	—	—	75	12,000	.7	.6	.5	.4
14	1.0	11	1.0	83	15,000	.6	.5	.6	.4
15	.5	6.3	1.0	45	11,500	—	.4	.3	.2
					TOTAL	5.6	6.6	2.4	3.7

Well number in modeled area	Potential yield for 200 days for indicated well combinations (mgd)
2	0.4
3	.4
4	.2
5	—
6	—
7	—
8	—
9	.1
10	.3
11	—
12	—
13	.2
14	.4
15	—
	3.9

TENMILE RIVER VALLEY AND COASTAL AREA

(Area H)

The Tenmile River and the brackish Providence and Seekonk Rivers drain 7 and 8 square miles of the study area, respectively. The area draining to brackish water is referred to herein as the Coastal area. Most of the stratified-drift aquifer within these two drainage areas constitutes part of a ground-water reservoir that extends eastward and northeastward from the Providence and Seekonk Rivers into Massachusetts. The area of the reservoir in Rhode