QUALITY OF WATER

QUALITY OF WATER

CHEMICAL QUALITY OF PRECIPITATION

Three precipitation stations for collecting water samples (table 1) were operated for about 8 months. Variations in quality were wide from station to station and from rainfall to rainfall (figures 1 and 2).

The quality of surface and subsurface waters is the end product of their environment. Similarly, the quality of precipitation is fashioned by its environment. In the basin, limestone is the predominant rock. Weathering and quarrying of limestone creates minute dust particles rich in calcium and bicarbonate which are carried into the atmosphere, and later washed out by falling precipitation. At times the concentrations of sulfate are greater than those of calcium; this results from contamination of air with soot, coal dust, and gaseous materials from combustion. The presence of sulfate is common; how much is washed out varies with the intensity and period of precipitation. The end result is that the chemical quality of precipitation is very erratic from place to place and from time to time.

Although precipitation contributes some mineralization to the surface and ground waters in the basin, it would be difficult to determine how much of the calcium, magnesium, and bicarbonate in these waters was carried over. Most waters in the basin obtain these constituents from earth-surface materials (soil and rock), more so than from precipitation. To segregate the contribution from either source would be difficult.

Sulfate in precipitation carried over into surface and ground water is another matter. In all these waters the concentrations of sulfate are in about the same range; therefore, other sources of sulfates not excluded, the contribution from precipitation is believed to be substantial.

In the highlands along the east and west margins of the basin, where noncarbonate hard rock crops out, only small amounts of mineral matter are dissolved by surface-water runoff and ground-water percolation because of the relative insolubility of the rocks. The mineral contribution from precipitation adds materially to the chemistry of the water in these areas.

TABLE 1.— *Range and average of concentrations of selected constituents and hardness, and range and median of pH in rainfall samples, Apr.–Nov. 1964*

Station and location[1]	Number of samples	Range of calcium	Average calcium	Range of bicarbonate	Average bicarbonate	Range of sulfate	Average sulfate	Range of hardness	Average hardness	Range of specific conductance	Average specific conductance	Range of pH	Median pH
		Parts per million								Micromhos at 25° C			
Pittsfield Lat. 42°26' Long. 73°18'	27 31 32	– 2.0-14 –	– 5.5 –	– – 4-54	– – 17	2.8-24 – –	14.0 – –	– – 4-42	– – 16	– – 27-156	– – 81	– – 5.76-6.9	– – 6.5
Stockbridge Lat. 42°17' Long. 73°18'	29 33 36 37	– 1.4-19 – –	– 4.2 – –	– – – 2-35	– – – 9	2.4-19 – – –	8.2 – – –	– – – 2-54	– – – 11	– – – 10-132	– – – 47	– – 5.2-7.5 –	– – 6.1 –
South Egremont Lat. 42°09' Long. 73°25'	24 30	– 1.8-19	– 6.9	– 6-44	– 18	3.6-44 –	15.0 –	– 6-56	– 20	– 28-197	– 82	– 5.8-7.2	– 6.6

[1] Stations operated by the U.S. Weather Bureau.

FIGURE 1.— *Graph showing specific conductance and estimated dissolved solids of rainfall samples*

FIGURE 2.— *Graph showing hardness of rainfall samples*

CHEMICAL QUALITY OF STREAMS

About 400 tons of dissolved mineral matter daily is carried out of the State by the Housatonic River. Each of the major and minor tributaries to the Housatonic River adds its load to the main stem. The East Branch of the Housatonic River at Coltsville contributes about 40 tons per day from a drainage area of 57 square miles. At Van Deusenville, from a drainage area of 280 square miles, the mineral load totals about 200 tons per day. A short distance downstream inflow from the Green River adds about another 30 tons. Other tributaries contribute their share. This section discusses the significance of this mineralization, and its relative inconsistencies in time and place.

To obtain the necessary flow and water chemistry data, three short-term sampling stations were operated in the basin. They were located at the permanent stream-gaging stations. Water samples were collected monthly at these stations from April through September 1964. The water samples were analyzed for their chemical content; the analyses, which appear in table 2, include some made from samples which were collected previous to the time of this study.

The chemical quality of water in the Housatonic River varies with streamflow. This effect is apparent from a comparison of the dissolved solids and discharge data listed in table 2. The comparison also is shown graphically in figure 3 for the samples collected from the river near Great Barrington. During low-flow periods a large percent of the water in the stream originated as ground water which normally is more highly mineralized than surface water.

As streamflow increases, the dilution effect of greater amounts of surface water decreases the dissolved-solids concentration. This dilution continues until the dissolved-solids content of the river water approaches that of the diluting surface water. This is shown in figure 3 where the dissolved-solids curve becomes asymptotic. Although the dissolved-solids *concentration* of the water decreases with increased streamflow, the total amount of dissolved minerals in the water will, of course, increase. Figure 3 illustrates this with a straight-line plot of the dissolved minerals, in tons per day, that flow past Great Barrington.

The chemical quality of water in the Housatonic River also varies from place to place within the basin. Some of this variability, shown in table 2 and figure 4, reflects the geology of the drainage area. The East Branch of the Housatonic drains an area of only slightly soluble crystalline rocks in its headwaters in Hinsdale and an area of relatively highly soluble carbonate rocks farther downstream in Dalton and Pittsfield. Although the upper reaches of the Green River traverses an area of Berkshire Schist, most of its drainage area is underlain by carbonate rocks. The Housatonic River at Great Barrington drains an area of about 280 square miles bringing in water of low mineral content from the steep hills of crystalline rocks to the east and from ridges of schist to the west. However, the more soluble carbonate rocks predominate throughout the basin.

As it would be expected, the principal mineral constituents in the water at all 3 sampling points (see table 2) were calcium and bicarbonate, the major components of carbonate rocks. Also, as shown in table 2 and figure 4, the range in concentration of these constituents is quite similar. The variability of iron in these samples probably is most striking. At the Houstonic River sampling site at Great Barrington the iron content of the samples ranges from 0.05 to 0.35 ppm. The occurrence of the higher concentrations of iron at this point is erratic and apparently unrelated to streamflow or seasonal variations. It most likely is a result of industrial pollution. Iron can be a troublesome constituent in water; as little as 0.3 ppm will precipitate and form a brown discoloration.

Sodium, at times, also is higher in this part of the river than might be expected under normal conditions. Concurrently, chloride and sulfate concentrations are high and they contribute to the noncarbonate hardness in the water.

TABLE 2.— *Chemical analyses of water samples collected periodically at three stream-gaging stations*

(Parts per million)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180° C)	Hardness as $CaCO_3$: Ca, Mg	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color	Turbidity	ABS
East Branch Housatonic River at Coltsville, Mass.																				
Sept. 10, 1963	23	3.5	0.16	24	9.7	9.7	1.5	112	20	8.0	0.1	0.2	142	100	8	261	6.8	9		
Dec. 3, 1963	65		.11	16	6.3	4.0	1.0	56	20	5.2				66	20	157	6.2			
Apr. 6, 1964	178	3.7	.11	12	4.4	4.4	.6	40	14	8.0	.1	.9	72	48	15	125	6.7	7		
May 4, 1964	61	3.2	.19	18	7.1	4.9	.7	70	16	7.0	.2	2.6	100	74	17	175	7.2	8		
June 9, 1964	27	3.2	.26	28	11	11	1.5	114	25	13	.2	4.6	156	115	22	278	6.9	4	0.5	
July 20, 1964	37	2.6	.21	23	6.2	4.1	1.0	91	11	6.0	.1	2.1	103	83	8	187	6.9	2	.7	0.0
July 29, 1964	11		.12	30	13	6.4		146	15	9.0		2.7		130	10	275	7.4		.4	.1
Aug. 18, 1964	19	3.9	.18	29	13	10	1.1	128	26	10	.0	4.1	166	126	21	291	7.2	4	1	.0
Sept. 14, 1964	16	3.3	.21	27	11	6.0	1.2	118	14	8.5	.1	3.3	137	112	16	243	7.0	5	.6	.0
Oct. 26, 1964	18	3.8	.14	25	11	7.5	1.1	119	14	10	.0	2.7	137	108	10	244	7.2	11	.8	
Housatonic River near Great Barrington, Mass.																				
Dec. 17, 1956	803	4.0	.10	22	8.4	6.7	1.2	94	18	6.8	.1	2.4	120	90	12	205	7.1	14		
May 12, 1958	1,880	3.3	.35	23	8.4	4.5	.9	95	16	5.6	.1	1.4	115	92	14	201	6.7	7		
June 10, 1958	650	3.0	.21	30	12	7.0	1.6	129	21	8.0	.1	2.4	157	125	19	273	6.8	7		
Nov. 10, 1958	728	4.2	.19	24	7.7	4.2	1.7	96	14	6.0	.0	1.3	120	92	13	206	7.0	7		
Dec. 9, 1958	507	4.4	.12	26	10	4.6	1.2	103	17	7.5	.1	2.0	128	106	22	216	7.1	5		
Apr. 6, 1959	1,910	3.0	.05	16	4.9	2.7	1.0	58	11	4.2	.0	1.9	84	60	13	132	6.9	10		
Sept. 10, 1963	95	3.2	.14	34	12	19	2.7	152	32	14	.1	.8	212	135	10	369	6.9	14		
Dec. 3, 1963	442		.26	22	7.3	5.2	1.3	75	21	8.0				85	27	198	6.7			
Apr. 6, 1964	923	3.0	.15	21	6.2	5.3	.6	74	16	9.0	.1	1.2	102	78	18	185	7.2	7		
May 4, 1964	437	1.2	.40	30	10	8.6	1.1	116	21	11	.1	1.2	149	116	21	264	7.1	12		
June 9, 1964	183	2.6	.34	35	12	17	2.0	146	30	16	.2	3.1	198	137	18	343	7.0	19	.4	
July 20, 1964	163	3.3	.07	32	12	11	1.9	128	26	14	.0	5.8	175	130	24	304	7.0	7	.8	.1
Aug. 6, 1964	96		.17	38	11	16		138	44	16				142	29	347	7.4			
Aug. 18, 1964	102	3.1	.16	35	12	21	2.6	142	39	18	.0	2.7	212	137	20	360	6.9	14	.6	.1
Sept. 14, 1964	112	3.3	.14	35	13	18	2.5	148	36	16	.1	3.1	207	141	20	354	7.1	20	1	.2
Green River near Great Barrington, Mass.																				
Sept. 10, 1963	4.1	4.2	.00	33	8.8	2.3	.7	126	14	3.8	.1	1.2	132	119	15	238	7.2	3		
Apr. 6, 1964	128	3.6	.03	19	4.5	2.3	.1	62	13	4.0	.0	.9	80	66	15	143	7.7	3		
May 4, 1964	19	3.2	.03	23	5.5	2.4	.1	79	13	4.9	.0	.9	92	80	16	168	7.3	2		
June 9, 1964	68	4.9	.02	29	7.8	2.5	.5	104	13	5.9	.0	1.1	119	104	20	204	7.9	3	1	.0
July 20, 1964	4.8	5.2	.02	34	9.4	2.4	.0	126	14	5.0	.0	1.7	135	124	20	238	7.7	3		
Aug. 6, 1964	3.9		.22	33	9.1	2.5		129	14	5.3				120	14	239	7.7	3		.3
Aug. 18, 1964	3.9	5.6	.02	34	10	2.4	.7	130	14	5.0	.0	1.3	140	126	20	244	7.7	3	.8	.0
Sept. 14, 1964	3.6	4.4	.01	35	9.5	2.4	.8	132	14	5.1	.0	1.5	140	127	18	247	7.7	3	.6	.0

FIGURE 3.— *Graph showing variation of dissolved solids and hardness with discharge, Housatonic River near Great Barrington, 1963–64*

FIGURE 4.— *Graphs showing range of dissolved solids, hardness, iron, and pH at three stream-gaging stations*

A East Branch Housatonic River at Coltsville
B Housatonic River near Great Barrington
C Green River near Great Barrington

TIME-OF-TRAVEL STUDY

A time-of-travel study was conducted on the Housatonic River during the low-flow period of October 1964. The reach selected was from the U.S. Geological Survey gaging station at Coltsville, Massachusetts to the last bridge before the Connecticut State line, a distance of 51.7 river miles as shown on the pollution classification and time-of-travel map. The reach, which contains 10 reservoirs, falls 353 feet at a very irregular gradient.

Discharge remained fairly constant throughout the study with an average flow of 22 cfs (cubic feet per second) at the Coltsville gage and 130 cfs at the gage near Great Barrington. To expedite the study the reach was divided into four subreaches, and dye (Rhodamine B) was injected at upstream end of each subreach.

The total travel time of the peak concentration for the 51.7 miles from Coltsville to Ashley Falls was 284.5 hours, or roughly 12 days. For easy comparison with all the subreaches, a condensed summary of results is listed in table 5.

The travel time in the first subreach was longer than required in any other of the subreaches and was attributed to a significant decrease in velocity of the dye cloud as it moved through Woods Pond, above the first reservoir. The dye cloud also had the broadest peak here with the lowest concentration of dye as a result of complete mixing as illustrated on the pollution classification and time-of-travel map.

The travel time of the peak concentration in the second subreach was rapid in comparison to the time required in the other subreaches, considering that this subreach contained the greatest number of reservoirs. The velocity through the first dam was very slow but it picked up considerably through the remaining dams resulting in the second highest average velocity of the peak concentrations in the four subreaches.

The peak concentration in the third subreach took 44 hours to pass through the first 3 reservoirs and 23 hours to pass through the final reservoir.

In comparison with length, the travel time of the peak concentration in the fourth subreach was considerably faster than the time required to travel the other three reaches. The absence of reservoirs accounted for this increased velocity.

This time-of-travel study was made under one set of flow conditions and the travel rates should not be used if the discharge rates are different from those prevailing when the investigation was made. Mills on the Housatonic River do cause diurnal fluctuation but it is thought that the flow was indicative of the normal flow for the range of discharge. An additional time-of-travel run at a higher discharge would permit an extension of results to cover a wider range of flow conditions.

Time-of-travel studies dealing with soluble contaminants are becoming more and more in demand today. Information is needed in connection with pollution control and abatement measures to determine dilution rates of industrial and domestic wastes, both treated and untreated. Civil Defense planning would require studies of this type so that arrival and passage time of a harmful contaminant in concentrations above a critical level could be predicted.

A graphical presentation of the time-distance curves, river profile, and discharge profile is shown in figure 5.

FIGURE 5.— *Graphical presentation of time-distance curves, river profile, and discharge profile*

TABLE 5.— *Summary of results, time-of-travel study*

Subreach	Length (miles)	Average discharge at injection site (cfs)	Amount of dye injected (pounds)	Travel time of leading edge (hours)	Travel time of peak concentration (hours)	Approximate peak concentration[1] (ppb)
A. Coltsville gage to Lenox Station	13.7	22	1.0	79	98.5	0.6
B. Lenox Station to Route 7	10.0	48	1.7	47.5	54	2.8
C. Route 7 to Great Barrington gage	8.0	75e	.6	52.5	67	.9
D. Great Barrington gage to Andrus Road	20.0	130	2.0	57.5	65	4.8
Totals	51.7	–	5.3	236.5	284.5	–

[1] At lower end of subreach
e—estimated
cfs—cubic feet per second
ppb—parts per billion

ANALYSIS OF GROUND WATER

During this investigation water samples were collected from 43 wells in the basin and were analyzed for chemical constituents. The locations of these wells are shown on the ground-water-quality map. Because ground-water quality is not consistently the same throughout the year, water from 40 of the wells was sampled twice, once in early spring when water levels were high in the ground, and again in late summer when water levels were low in the ground. A decrease in the volume of water in an aquifer generally causes an increase in the mineralization of the water.

Table 3 summarizes the chemical quality of the ground waters found in the different aquifers in the basin. Except for the iron content in a few places, the quality of the natural ground waters meets U.S. Public Health Service standards (U.S. Department of Health, Education, and Welfare, 1962); following are some of the recommended limits for chemical drinking water standards proposed by the USPHS:

Element	Content (ppm)
Iron (Fe)	0.3
Manganese (Mn)	.05
Magnesium (Mg)	50
Sulfate (SO_4)	250
Chloride (Cl)	250
Fluoride (F; must not exceed 3.0)	1.0
Detergents (as alkyl benzene sulfonate, ABS)	.5
Total solids	500

GEOCHEMICAL DISTRIBUTION OF GROUND WATER

The ground-water-quality map shows the generalized areal geochemical distribution of ground water throughout the basin. Bar graphs show general quality of water in various rock types and the average for wells that were sampled twice.

Comparison of the heights of the dissolved-solids bars infers a relative mineralization pattern of ground-water distribution. Water in the gneissic, schistose, and quartzitic rocks around the periphery of the basin are low in dissolved solids. Even water in the carbonate rocks around the periphery are relatively low, with the possible exception of the water in well Canaan 1. Water in the carbonate aquifers becomes progressively more mineralized south of Pittsfield and farther on downstream toward the central valleys, reaching its maximum mineralization in well Sheffield 63 near the Massachusetts-Connecticut State line.

Water mineralization in the surficial sand and gravel aquifers follows no areal pattern but apparently is controlled by the chemical composition of the deposits at each locality, as is also true for water in the till aquifers.

TABLE 3.— *Summary of chemical quality data of water from selected wells in surficial and bedrock aquifers*

Constituent or characteristic	Stratified deposits (Sand and gravel): Range (ppm)	No. of samples	Till: Range (ppm)	No. of samples	Limestone and dolomite (Carbonates): Range (ppm)	No. of samples	Quartzite: Range (ppm)	No. of samples	Gneiss: Range (ppm)	No. of samples	Schist: Range (ppm)	No. of samples
Silica (SiO_2)	3.4 - 12	12	3.6 - 7.2	4	3.5 - 9.2	15	7.9 - 11	3	8.8 - 15	4	3.3 - 11	6
Iron (Fe)	.01 - 1.1	16	.04 - .07	4	.00 - .10	16	.00 - .03	3	.03 - .99	5	.01 - 1.2	10
Manganese (Mn)	.00 - .22	12	.00 - .10	4	.00 - .06	15	.00	3	.00 - .07	5	.01 - .46	8
Calcium (Ca)	6.4 - 68	18	19 - 78	7	28 - 85	23	9.6 - 42	3	13 - 26	5	16 - 40	7
Magnesium (Mg)	.9 - 36	18	5.5 - 26	7	8.8 - 36	23	2.2 - 17	3	2.8 - 13	5	1.0 - 16	6
Sodium (Na)	1.1 - 8.5	12	1.1 - 9.5	5	1.3 - 5.3	12	1.1 - 3.7	3	1.7 - 3.6	4	.7 - 16	6
Potassium (K)	.1 - 3.8	12	.4 - 2.2	4	.2 - 3.0	15	.9 - 4.4	3	1.0 - 2.2	4	.2 - 1.4	6
Bicarbonate (HCO_3)	12 - 312	22	34 - 302	8	112 - 340	29	38 - 164	6	59 - 158	8	41 - 169	10
Sulfate (SO_4)	11 - 29	12	12 - 27	5	9.0 - 28	17	4.4 - 19	3	4.8 - 17	4	.2 - 22	6
Chloride (Cl)	1.0 - 21	12	2.0 - 28	6	.8 - 22	12	1.0 - 13	4	1.1 - 8.0	4	1.0 - 22	6
Fluoride (F)	.0 - .2	12	.0 - .1	4	.0 - .1	15	.1 - .2	3	.0 - .1	4	.0 - .2	6
Nitrate (NO_3)	.0 - 6.8	12	.2 - 20	6	.1 - 19	17	.9 - 14	3	.0 - 3.7	4	.0 - 18	6
Dissolved solids (residue on evaporation at 180° C)	29 - 278	12	99 - 245	4	141 - 308	11	50 - 222	3	74 - 132	4	59 - 176	6
Hardness as $CaCO_3$: Calcium, magnesium	20 - 270	22	74 - 302	8	106 - 356	29	32 - 175	6	44 - 143	8	44 - 143	10
Noncarbonate	0 - 48	22	8 - 58	8	4 - 141	29	1 - 41	6	0 - 14	8	0 - 18	10
Specific conductance (micromhos at 25° C)	48 - 512	22	168 - 567	8	208 - 874	29	72 - 358	6	107 - 282	8	96 - 289	10
pH	6.6 - 8.2	22	6.9 - 8.4	8	7.1 - 8.3	29	7.1 - 7.8	6	7.5 - 9.0	8	6.7 - 8.1	10
Color	1 - 4	12	1 - 4	4	1 - 3	15	1	1	1 - 2	4	0 - 6	6
Turbidity	.3 - .5	3	2	1	.1	1	–	–	.7	1	1	1
Temperature (°F)	36 - 56	22	38 - 54	8	45 - 59	29	46 - 54	6	43 - 57	8	41 - 56	9

TABLE 4.— *Chemical constituents, in percent, in the major types of rock*[1]

Sample no.	Rock name	Silicon dioxide (SiO_2)	Aluminum oxide (Al_2O_3)	Ferric oxide (Fe_2O_3)	Ferrous oxide (FeO)	Magnesium oxide (MgO)	Calcium oxide (CaO)	Sodium oxide (Na_2O)	Potassium oxide (K_2O)	Hydrogen oxide (+) (H_2O+)	Hydrogen oxide (−) (H_2O-)	Titanium dioxide (TiO_2)	Phosphorous pentoxide (P_2O_5)	Manganese oxide (MnO)	Carbon dioxide (CO_2)	Chloride (Cl)	Fluoride (F)
H-1	Berkshire Schist	69.55	14.25	0.65	5.22	1.80	0.54	0.58	2.81	2.96	0.01	0.66	0.10	0.15	0.50	0.01	0.07
H-2	Hinsdale Gneiss	73.39	13.88	.47	1.52	.63	1.10	5.87	2.00	.41	.03	.43	.10	.02	.00	.02	.07
H-3	Cheshire Quartzite	94.69	2.58	.09	.11	.06	.00	.11	1.66	.21	.01	.19	.02	.00	.01	.01	.01
H-4	Stockbridge Formation	2.17	.21	.27	.18	20.51	30.01	.10	.31	.01	.01	.02	.00	.02	45.80	.02	.01
H-6	do.	.38	.11	.04	.02	.51	55.00	.08	.08	.03	.00	.01	.00	.00	43.71	.01	.00
H-7	do.	2.56	.71	.02	.44	17.53	32.83	.12	.34	.01	.00	.31	.02	.01	44.76	.01	.01
H-8	Berkshire Schist	58.52	21.94	1.78	5.87	1.74	.47	2.76	1.07	3.63	.04	1.03	.16	.15	.18	.01	.08
H-10	do.	56.30	21.80	.93	6.93	2.35	1.02	4.35	1.07	2.95	.03	.88	.10	.11	.07	.00	.10
H-11	Becket Gneiss	73.96	12.28	1.22	2.59	.43	.69	2.51	5.42	.48	.05	.22	.01	.03	.04	.01	.04
H-12	Cheshire Quartzite	98.96	.27	.11	.14	.00	.00	.05	.08	.02	.02	.05	.00	.00	.00	.01	.00

[1] Analyses by U.S. Geological Survey

POLLUTION

Streams are a convenient means of disposing of domestic and industrial wastes. But, if not properly treated, discharge of such wastes tends to degrade the water quality and reduce the utility of the water. The extent of degradation varies with the amount and kind of wastes discharged into a stream. Domestic wastes containing organic material may reduce the oxygen content, increase the nitrogen content in its various forms, increase the acidity, add phosphates, and produce foam resulting from the use and discharge of detergents. Industrial activities can contribute as much and more. Acids, alkalies, metals of all kinds (some even toxic) can add to the mineral content of the water. Solid material such as fibers increase the turbidity and also reduce the dissolved-oxygen content. Pesticides and herbicides are recent additions to the family of pollutants that can create problems. The end result may be a water of poor quality and limited utility.

Pollution is one of the major water-quality problems in the basin, particularly in the main stem and its larger tributaries. Some of the towns in the basin discharge raw sewage into the rivers, other towns have limited (inadequate) facilities for treating wastes prior to discharge into the river. Industries, principally paper and textile, also are heavy contributors to the pollution load. Stretches of the main stem of the river and some of the tributaries are unsatisfactory for use as water-supply sources or for recreational purposes.

Because of these conditions, the Housatonic River was classified in 1957 by the New England Interstate Water Pollution Control Commission. The pollution classification and time of travel map shows the stretches of streams and their classification. Table 6 shows the criteria used as the basis for classification.

Since the initial survey, progress has been made to alleviate the pollution condition of the Housatonic River and its tributaries. New treatment facilities are being or have been constructed in order to provide adequate treatment. Pittsfield, for example, completed a new treatment plant in 1963 that is also serving the town of Dalton via an interceptor sewer. Lenox and North Lenox are now providing adequate treatment. Stockbridge, which has one of the oldest treatment plants in the State, is adequately treating its wastes. Lee and Great Barrington also have plans for developing facilities for treating wastes prior to discharge into the river.

Similarly, industries in the basin are taking steps to reduce the pollution by using settling tanks or lagoons to remove settleable solids. Others are using the existing municipal facilities for disposal of their wastes.

TABLE 6.— *Classification and standards of quality for interstate waters*[1]
(as revised and adopted October 1, 1959)

	CLASS A	CLASS B	CLASS C	CLASS D
Suitability for use	Suitable for any water use. Character uniformly excellent.	Suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value. Acceptable for public water supply with filtration and disinfection.	Suitable for recreational boating, irrigation of crops not used for consumption without cooking; habitat for wildlife and common food and game fishes indigenous to the region; industrial cooling and most industrial process uses.	Suitable for transportation of sewage and industrial wastes without nuisance, and for power, navigation and certain industrial uses.
Standards of quality				
Dissolved oxygen	Not less than 75% sat.	Not less than 75% sat.	Not less than 5 p.p.m.	Present at all times
Oil and grease	None	No appreciable amount	Not objectionable	Not objectionable
Odor, scum, floating solids, or debris	None	None	None	Not objectionable
Sludge deposits	None	None	None	Not objectionable
Color and turbidity	None	Not objectionable	Not objectionable	Not objectionable
Phenols or other taste producing substances	None	None	None	
Substances potentially toxic	None	None	Not in toxic concentrations or combinations	Not in toxic concentrations or combinations
Free acids or alkalies	None	None	None	Not in objectionable amounts
Radioactivity	Within limits approved by the appropriate State agency with consideration of possible adverse effects in downstream waters from discharge of radioactive wastes; limits in a particular watershed to be resolved when necessary after consultation between States involved.			
Coliform bacteria	Within limits approved by State Department of Health for uses involved.*	Bacterial content of bathing waters shall meet limits approved by State Department of Health and acceptability will depend on sanitary survey.		

*Sea waters used for the taking of market shellfish shall not have a median coliform content in excess of 70 per 100 ml.

NOTE: Waters falling below these descriptions are considered as unsatisfactory and as Class E.
These standards do not apply to conditions brought about by natural causes.
For purpose of distinction as to use, waters used or proposed for public water supply shall be so designated.

[1] New England Interstate Water Pollution Control Commission

WATER QUALITY IN LAKES, PONDS, AND RESERVOIRS

The chemical composition of surface-water bodies (lakes, ponds, and reservoirs) tends to be an "averaging" of the composition of the streams that flow into them. Assuming thorough mixing in the smaller and shallower bodies, the chemical composition is fairly uniform. However, in the larger and deeper bodies, distinct stratified layers of water may occur having different chemical and physical qualities. Stratification occurs when there are differences in water density resulting from differences in temperature, suspended matter, or dissolved salts.

There is a tendency for lakes to stratify in accordance with temperature layers, because the density (weight) of water increases with a decrease in temperature until it reaches 39.2°F, then the density decreases to the 32°F mark. This layering effect caused by thermal differences in Lake Onota is shown in figure 6.

The dissolved oxygen content also changes with depth. Concentrations are highest near the surface and gradually decrease with depth into a reducing environment. In this environment previously precipitated iron and manganese may go back into solution, decreasing the quality and increasing the color and turbidity.

Another phenomenon which may occur in stratified lakes is density currents. Because waters of different density resist mixing, a stream may flow into and through a lake in one mass density current without mixing with the water in the lake.

Table 7 gives the chemical analyses for 18 selected lakes, ponds, and reservoirs in the basin. They are located on the water use map shown on sheet 1. The samples for analysis were taken at the surface of the various water bodies and are representative of the average quality of the smaller bodies, but may not include the effects of stratification in the larger ones.

FIGURE 6.— *Graph showing temperature gradient and dissolved-oxygen concentrations, Onota Lake, Pittsfield, Mass, 5:45 PM, Sept. 3, 1964*
(Data furnished by the Massachusetts Division of Fisheries and Game)

Dissolved oxygen at: 30 ft—8.4 ppm; 35 ft—6.7 ppm; 38 ft—2.6 ppm; 40 ft—0.7 ppm. Epilimnion; Thermocline; Hypolimnion.

TABLE 7.— *Chemical quality of water from selected lakes, ponds, and reservoirs*

(Parts per million)

Source and location	Date	Water temperature (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids residue on evaporation at 180° C)	Hardness as $CaCO_3$: Ca, Mg	Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color	Turbidity	ABS
Agawam Lake 1.2 mi. southwest of Stockbridge	9/2/64	60	–	0.08	35	15	2.8	–	158	15	7.8	–	–	–	148	18	296	7.2	–	–	–
Anthony Brook Reservoir 2.2 mi. north of Dalton	9/15/64	52	–	.03	2.5	1.4	1.0	–	8	8.0	0.7	–	–	31	12	6	38	6.5	–	–	–
Ashley Reservoir 3.8 mi. southeast of Pittsfield	10/5/64	53	0.8	.10	6.2	2.8	.8	0.6	23	9.0	1.0	0.0	0.2	36	27	8	61	6.8	7	0.7	0.0
Aspinwall Reservoir 2.1 mi. northwest of Lenox	9/3/64	62	–	.24	21	2.1	1.5	–	61	15	.0	–	–	–	61	11	136	7.0	–	–	–
Belmont Reservoir 1.2 mi. southwest of Hinsdale	2/19/65	–	3.7	.13	2.6	.6	1.2	.9	2	8.1	.7	.2	.1	22	9	8	37	5.1	2	.5	–
Berkshire Hgts. Reservoir 0.7 mi. west of Great Barrington	9/3/64	66	–	.03	32	10	2.7	–	130	14	4.1	–	–	–	121	14	243	8.2	–	–	–
Cleveland Brook Reservoir 5.3 mi. northeast of Pittsfield	10/5/64	49	7.0	.10	17	4.5	3.6	1.2	62	12	6.8	.0	.0	83	61	10	136	7.5	5	.4	.0
East Mountain Reservoir 0.8 mi. southeast of Great Barrington	9/3/64	68	–	.04	33	9.6	2.6	–	132	14	4.1	–	–	–	122	14	249	7.5	–	–	–
Egypt Brook Reservoir 2.5 mi. north of Dalton	9/15/64	57	–	.11	3.7	1.7	.7	–	14	5.8	.2	–	–	30	16	4	40	6.9	–	–	–
Goodale Brook Reservoir,[1] Egremont	–	–	–	–	–	–	–	–	34	–	4.5	–	.0	–	39	–	–	7.0	–	–	–
Goose Pond 3.3 mi. southeast of Lee	9/2/64	72	–	.03	6.0	1.4	1.2	–	20	8.2	–	–	–	–	21	4	55	7.0	–	–	–
Lake Averic 1.7 mi. west of Interlaken	9/2/64	75	–	–	13	4.7	1.3	–	55	8.6	.0	–	–	–	52	7	111	7.3	–	–	–
Lake Buel 4.9 mi. southeast of Great Barrington	9/3/64	70	–	.01	27	15	2.2	–	148	8.8	4.4	–	–	–	128	7	260	7.6	–	–	–
Lake Garfield 9.7 mi. north of Monterey	9/3/64	70	–	.08	9.4	4.5	2.4	–	45	6.8	3.8	–	–	–	42	5	108	7.0	–	–	–
Long Pond 2.7 mi. northeast of Great Barrington	9/3/64	72	–	–	20	7.5	1.1	–	90	8.4	.1	–	–	–	81	7	163	7.4	–	–	–
Lower Root Reservoir 2.3 mi. northwest of Lenox	9/3/64	72	–	.04	21	4.7	1.3	–	78	9.6	.0	–	–	–	72	8	147	7.5	–	–	–
Mill Brook Reservoir 4.2 mi. southeast of Pittsfield	10/5/64	57	2.3	.48	4.8	1.8	0.9	.5	10	9.4	0.8	.1	0.5	34	20	12	47	6.5	24	.7	.0
Onota Lake 2.7 mi. northwest of Pittsfield	9/14/64	63	–	.34	23	8.1	2.6	–	102	8.0	–	–	–	101	91	8	191	7.4	–	.8	–
Pontoosuc Lake 2.9 mi. north of Pittsfield	9/14/64	66	1.0	.01	26	6.2	4.0	.7	94	11	7.8	.0	1.1	106	90	14	199	7.4	14	1	.0
Richmond Pond 4.6 mi. southwest of Pittsfield	9/14/64	62	–	.08	20	8.0	3.0	–	78	14	11	–	–	106	83	19	189	8.0	–	–	–
Sackett Brook Reservoir 4.9 mi. southeast of Pittsfield	10/5/64	53	3.2	.07	10	5.0	1.2	.6	48	9.0	1.8	.0	.3	56	46	6	99	7.2	6	.4	.0
Stockbridge Bowl Lake 1.4 mi. north of Interlaken	9/2/64	71	–	.01	25	9.5	3.4	–	109	13	–	–	–	–	104	14	222	7.5	–	–	–
[illegible] Reservoir 1.5 mi. northeast of Lee	9/15/64	64	–	.16	2.7	.8	.9	–	4	8.6	.4	–	–	20	10	7	32	5.9	–	–	–
Washington Mountain Reservoir 2.4 mi. northeast of Lee	9/15/64	51	–	.56	3.0	4.0	1.2	–	22	5.8	2	–	–	53	24	6	63	6.7	–	–	–
Windsor Brook Reservoir 2.6 mi. northeast of Dalton	9/15/64	64	–	.08	10	2.4	2.6	–	32	9.2	4.4	–	–	51	35	9	90	7.0	–	–	–
Woolsey Reservoir 1.8 mi. northwest of Lenox	4/1/65	36	5.9	.06	15	1.6	1.7	.8	40	14	2.9	.1	.1	64	44	11	100	7.4	2	.5	–

[1] Average of 3 analyses for year 1963. Analyses furnished by the Massachusetts Department of Public Health.

MAP SHOWING LOCATIONS OF SURFACE-WATER SAMPLING SITES, POLLUTION CLASSIFICATION, TIME OF TRAVEL, AND DISPERSION CHARACTERISTICS

EXPLANATION
Injection point
Sampling point
Short-term sampling station at stream-gaging station
A—East Branch Housatonic River at Coltsville
B—Housatonic River near Great Barrington
C—Green River near Great Barrington
Pollution classification (see table 6): B, C, D, E
Basin boundary
Dam
Elapsed time after injection to first arrival
Elapsed time after injection to peak concentration

Base from U.S. Geological Survey 1:250,000, 1956
SCALE 1:125 000

MAP SHOWING LOCATIONS OF SELECTED WELLS, SITES AT WHICH LITHOLOGIC SAMPLES WERE COLLECTED AND BAR GRAPHS REPRESENTING QUALITY OF WATER DATA

EXPLANATION
Well: From which sample was collected for chemical analysis; number, preceded by name of town, refers to text; color is coded to rock type of aquifer, as shown below
Bedrock outcrop: From which sample was collected for rock analysis; number corresponds to same number in table 4; color is coded to rock type as shown below
Sand and gravel deposit: From which sample was collected for pebble count
Color code for rock types: Sand and gravel; Till; Schist; Limestone and dolomite; Quartzite; Gneiss
Basin boundary
Constituents, in parts per million (Color coded): (509) Dissolved solids; (342) Hardness as $CaCO_3$, Ca, and Mg

Base from U.S. Geological Survey 1:250,000, 1956
SCALE 1:125 000

CHEMICAL QUALITY OF GROUND WATER

The chemical quality of ground water is dependent upon its geologic and hydrologic environment. Precipitation is somewhat mineralized and, therefore, is the initial source of mineralization in ground water. That part of the precipitation which becomes ground water takes additional minerals into solution as it percolates through soils and rocks containing soluble salts. The amount of solution that takes place depends principally on the stability of the rock constituents, the size of the rock particles (area of contact), and the length of time of contact. Because the chemical and physical properties of the rocks are not the same throughout the basin, the quality of the ground water varies appreciably from place to place.

MINERALOGY OF AQUIFERS

There are four major groups of rocks in the basin. They are the carbonate, quartzitic, gneissic, and schistose rocks.

To help determine the sources of mineralization in ground water 10 rock samples were collected from the major rock types in the basin and chemical analyses made. The locations of the sampling sites are shown on the ground-water-quality map; the results of the analyses are listed in table 4.

In conjunction with the mapping of the surficial geology, pebble counts were made of some of the sand and gravel deposits in several of the stream valleys. The locations of these sample sites are also shown on the quality of water map above. The distribution of pebbles in the surficial deposits show a general relationship to the occurrence of local bedrock. That is, quartzitic and gneissic pebbles are abundant in the surficial deposits in the eastern part of the basin where these rock types crop out; and schistose pebbles are abundant in the western part of the basin where this rock type crops out. Carbonate pebbles are interspersed with the above mentioned rock types, largely in the deposits in the central valleys where carbonate rock crops out. The distribution of these rock types and their chemical composition should, therefore, be the major control for the source of mineralization of the ground water in the basin.

HYDROLOGY AND WATER RESOURCES OF THE HOUSATONIC RIVER BASIN, MASSACHUSETTS

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