GAZETTEER OF HYDROLOGIC CHARACTERISTICS OF STREAMS IN MASSACHUSETTS--BLACKSTONE RIVER BASIN

By S.William Wandle, Jr., and Anita F. Phipps

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 84-4286

Prepared in cooperation with the

COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF ENVIRONMENTAL QUALITY ENGINEERING

DIVISION OF WATER POLLUTION CONTROL

Boston, Massachusetts

1984

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

U.S. Geological Survey
150 Causeway Street, Suite 1309
Boston, MA 02114

Copies of this report can be purchased from:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Denver, CO 80225
Telephone: (303) 236-7476

CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS

The following factors may be used to convert the inch-pound units published herein to the International System of Units (SI).

Multiply inch-pound units	By	To obtain SI Units
	Length	
inch (in)	25.4*	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
	Slope	
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
	Temperature	

Temperature in degrees Fahrenheit (^oF) can be converted to degrees Celsius (^oC) as follows:

$$^oC = 5/9\ (^oF-32).$$

*Exact.

GAZETTEER OF HYDROLOGIC CHARACTERISTICS OF STREAMS IN MASSACHUSETTS--BLACKSTONE RIVER BASIN

By S. William Wandle, Jr., and Anita F. Phipps

ABSTRACT

The Blackstone River basin encompasses 335 square miles in south-central Massachusetts, including portions of Bristol, Middlesex, Norfolk, and Worcester Counties. Drainage areas, using the latest available 1:24,000 scale topographic maps, were computed for the first time for ungaged streams draining more than 3 square miles and were re-computed for data-collection sites.

Streamflow characteristics at six gaging stations were calculated using a new data base with daily flow records through 1980. These characteristics include annual and monthly flow statistics, duration of daily flow values, and the annual 7-day mean low flow at the 2-year and 10-year recurrence intervals. The 7-day, 10-year low-flow values are presented for 31 partial-record sites, and the procedures used to determine the hydrologic characteristics of the basin are summarized. Basin characteristics representing 14 commonly used indices to estimate various streamflows are presented for the six gaged streams. This gazetteer will aid in the planning and siting of water-resources related activities and will provide a common data base for governmental agencies and the engineering and planning communities.

INTRODUCTION

Information on hydrologic characteristics, including drainage areas, frequency of low flows, and duration of daily flows, is necessary to plan and manage water-resources related activities. Governmental agencies and the engineering and planning community need streamflow and basin characteristics to satisfy requirements relative to waste assimilation, fisheries management, hydropower, land-use planning, stream-systems analysis, and water-resource development and management. No current hydrologic data base containing a comprehensive list

of drainage areas, monthly flows, low-flow frequencies, and duration of daily flows is available for most of the Massachusetts stream systems. Drainage areas are available for selected sites where streamflow data are collected. Streamflow characteristics are presented in various reports, but these data, to be current, need to be re-analyzed using the latest available daily flow records.

In response to this need, a study was begun in 1980, in cooperation with the Massachusetts Division of Water Pollution Control, to analyze available streamflow and river-basin characteristics, and to compute subbasin drainage areas. This report is one in a series of gazetteers on the hydrologic characteristics of the major river basins in the State. Gazetteers are also available for the coastal river basins of the North Shore and Massachusetts Bay (Wandle, 1984a), Connecticut River basin (Wandle, 1984b), Hudson River basin (Wandle, 1984c), Merrimack River basin (Wandle and Fontaine, 1984), Taunton and Ten Mile River basins (Wandle and Keezer, 1984), Housatonic River basin (Wandle and Lippert, 1984), Thames River basin (Wandle and LeBlanc, 1984), and coastal river basins of the South Shore and Buzzards Bay (Wandle and Morgan, 1984). This report provides the first detailed listing of drainage areas and streamflow characteristics derived from daily flow records in the Blackstone River basin. The streamflow characteristics presented are an expansion and an update of those given in Walker and Krejmas (1983).

The Blackstone River basin in south-central Massachusetts (fig. 1) includes all or part of the following communities: Attleboro, Auburn, Bellingham, Blackstone, Boylston, Douglas, Franklin, Grafton, Holden, Hopedale, Hopkinton, Leicester, Mendon, Milford, Millbury, Millville, North Attleborough, Northbridge, Oxford, Paxton, Plainville, Shrewsbury, Sutton, Upton, Uxbridge, Webster, West Boylston, Westborough, Worcester, and Wrentham.

Streamflow characteristics presented for the five continuously gaged streams are based upon a new sample of daily flow records in comparison to flow records used in Higgins (1967), Knox and Soule (1949), and Male and Ogawa (1982). Streamflow records through the 1980 water year were available for this analysis. For each site, records were selected to represent a flow regime influenced by fairly constant river basin conditions (Wandle, 1983).

Drainage areas were computed for the first time for ungaged streams draining greater than 3 mi^2 and were re-computed for data-collection sites. Drainage divides, as delineated on the latest available 1:24,000 scale topographic quadrangle maps (Brackley and Wandle, 1982; Krejmas, 1982; and Wandle and Frimpter, 1982) were used to calculate drainage areas. Drainage areas for most of the long-term gaging stations in earlier reports were computed using the drainage divides as outlined on 1:31,680 or 1:62,500 scale topographic quadrangle maps.

Streamflow data used in this study are a part of the historic streamflow data collected under agreements with State and Federal agencies and the U.S. Geological Survey. Most of the low-flow discharge measurements used in determining low-flow estimates at partial-record sites were collected during the water-resources investigation of the Blackstone River basin (Walker and Krejmas, 1983). The file of basin characteristics was created during an evaluation of available streamflow data in central New England (Johnson, 1970). This file is an expansion of the characteristics abstracted by Langbein and others (1947), and by Benson (1962). Basin characteristics were updated and additional characteristics were entered as part of a study to define floodflow characteristics of small streams (Johnson and Tasker, 1974, and Wandle, 1982). The hierarchical stream list was compiled by the Massachusetts Division of Water Pollution Control and the Massachusetts Division of Fisheries and Wildlife (Halliwell and others, 1982).

Data tabulated include drainage areas, basin and streamflow characteristics for gaging stations, including annual and monthly flow statistics, duration of daily flow values, and the annual 7-day mean low flow at the 2-year and 10-year recurrence intervals. Estimates of the 7-day 10-year low flows for partial-record sites are also presented. An explanation of the procedures to determine the streamflow and basin characteristics is provided.

The authors thank the many persons who have kindly given time, information, and guidance during this study. Particular thanks are given to persons in the Geological Survey who assisted in the collection of the streamflow data, in the preparation of this report.

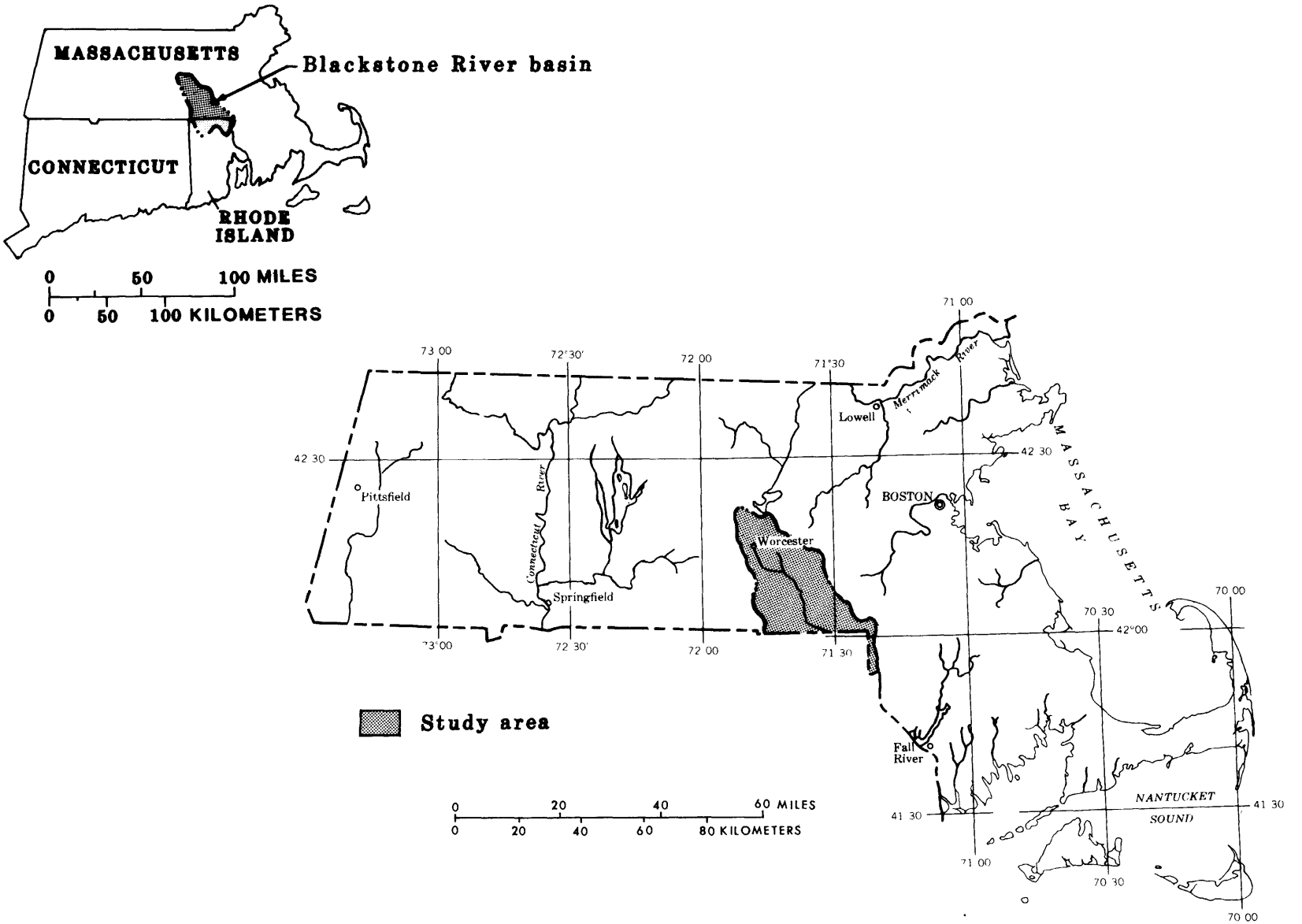

Figure 1.--Location of the Blackstone River basin

HYDROLOGIC DATA

Hydrologic characteristics are represented by various physical, climatic, and streamflow indices of a river basin. These characteristics can be determined either from available maps by following standardized procedures or from historic streamflow records.

Basin characteristics are indices of the physiography of the basin or of the climate prevailing over the basin and are measured on topographic quadrangle or climatic maps. Streamflow characteristics are computed from continuous records of daily flow or from a set of measurements during the occurrence of a specific event. Streamflow and basin characteristics are used in modeling stream quality, assessing water-resources conditions, analyzing impact of man's activities, and defining relationships to estimate flows or stream-quality parameters at ungaged sites.

Basin Characteristics

Drainage area is one of the most important variables in any hydrologic investigation or in the design of riverine structures. Drainage area is the most significant variable in the northeast that influences all streamflow except perhaps low flow in some regions. The physical boundary for many water-related studies corresponds to the limits for the drainage area upstream from the site.

For this study, drainage areas listed in table 1 (at the end of the report) were determined for the following sites:

1. Survey data-collection sites shown in figure 2. These sites include continuous-record gaging stations given in table 2 (at the end of the report), low-flow partial-record stations, miscellaneous sites, and water-quality stations.

2. Locations where the drainage area is greater than 3 mi^2.

3. Successive sites along a stream where the area between sites is at least 6 mi^2 on tributary streams and 10 mi^2 on the Blackstone River.

The drainage basin divides for these sites were delineated on the latest available 1:24,000 scale topographic quadrangle maps. Subbasin drainage divides are shown in the series of statewide reports, "Drainage Divides, Massachusetts." The Blackstone River basin is covered by three reports in this series—Nashua and Concord River basins (Brackley and Wandle, 1982), Blackstone and Thames River basins (Krejmas, 1982), and Taunton River basin and southeast coastal basins (Wandle and Frimpter, 1982).

The subbasin drainage areas given in table 1 are indexed to the Massachusetts stream inventory prepared by the Massachusetts Division of Water Pollution Control and the Massachusetts Division of Fisheries and Wildlife (Halliwell and others, 1982) with some modification. Drainage areas were computed for sites meeting one of the three criteria mentioned above. The entire stream listing is included as a reference for stream order. This hierarchical listing begins at the mouth of a major stream and proceeds upstream with tributary streams indented under the main-stem stream. This order is followed to list all the named streams. Unnamed tributaries are included to maintain the hierarchy. The reader is referred to the inventory of rivers and streams report by Halliwell and others (1982) for a more detailed explanation.

The basin characteristics listed below are included because they represent indices that would remain reasonably stable over a planning period. They can be used in predictive models to assess impacts of proposed developments. The usefulness of these characteristics to explain the variability of various streamflow events has been demonstrated in hydrologic analyses (Thomas and Benson, 1970) and they can readily be measured from available maps. The 14 basin indices given in table 3 (at the end of the report) were computed according to the procedures described below. The indices for elevation, storage, lake area, and forest can be computed by the grid method which is explained after all the procedures are described.

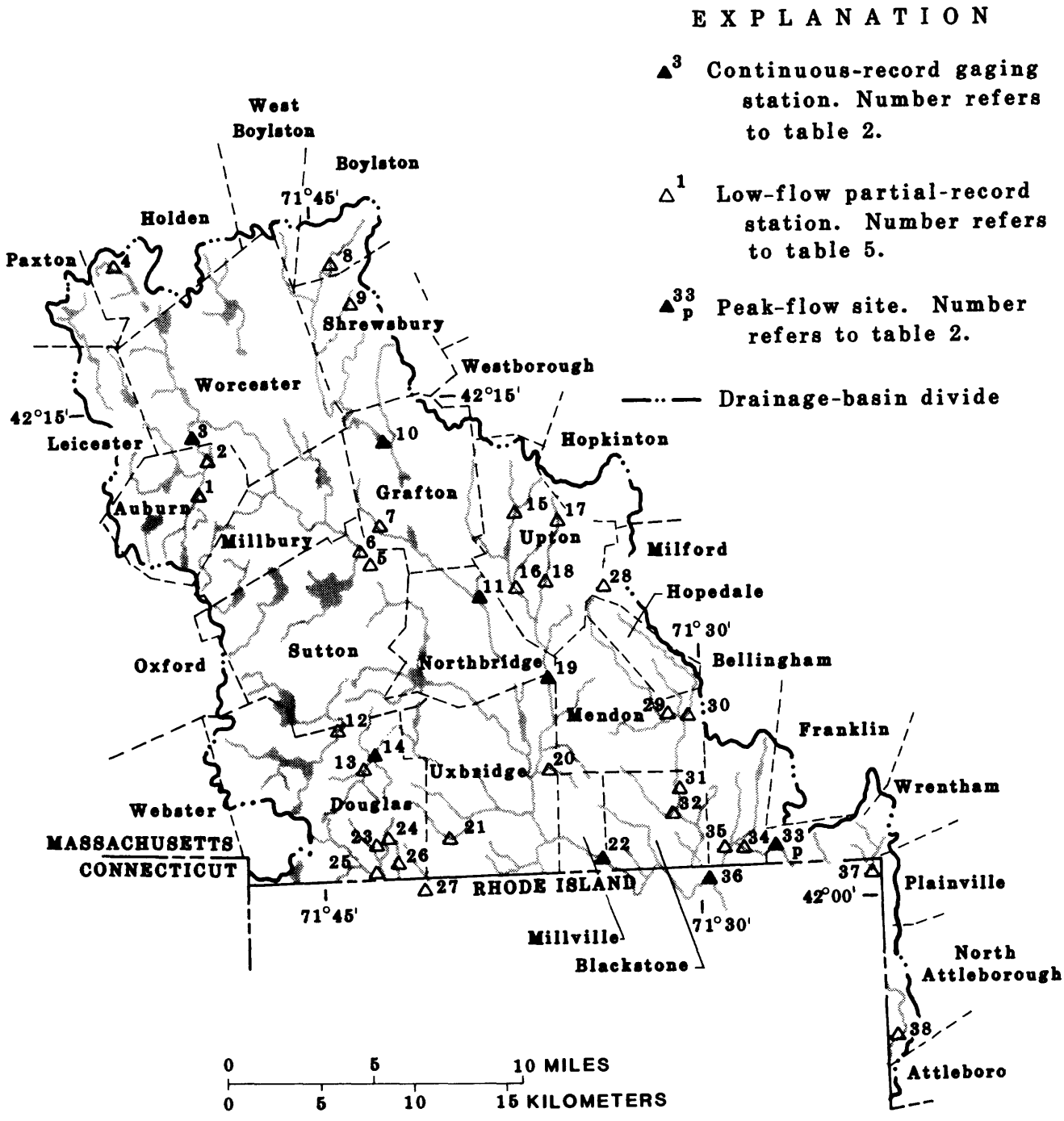

Figure 2.--Location of the gaging stations and low-flow partial-record stations in the Blackstone River basin

1. Drainage area—Area, in square miles, as measured on the most recent 1:24,000 scale topographic quadrangle maps. Drainage area, as defined in the "National Handbook of Recommended Methods for Water-Data Acquisition" (U.S. Geological Survey, 1977), is "...the area of a river basin, measured in a horizontal plane, that is enclosed by a topographic divide such that direct surface runoff from precipitation normally would drain by gravity into the river basin.". Drainage area boundary lines are traced on topographic maps along divides indicated by contour elevations, starting at the point on the stream for which the drainage area is desired. These lines are drawn to cross a contour at right angles. Interpolation between contours may be indicated by reference to trails, old roads, or firebreaks in forested areas, all of which frequently follow drainage divides. Detailed information may also be obtained from highway or street profiles, from examination of aerial photographs, and from ground reconnaissance. Subareas within each quadrangle map were computed with an electronic digitizer using the procedures of the U.S. Federal Inter-Agency River Basin Committee (1951) as a guide. The coefficients to compute square miles from digitizer units were calculated using the known area of each 7.5-minute quadrangle or of the appropriate 2.5-minute quadrilaterals. Drainage areas for the subbasins were computed by summing the contributing areas.
2. Slope—Main-channel slope, in feet per mile, determined from elevations at points 10 percent and 85 percent of the distance along the main channel from the gaging station to the basin divide.
3. Length—Main-channel length, in miles, from the gaging station to the basin divide, as measured with dividers set to 0.1 mile or with a map measurer.
4. Elevation--Mean basin elevation, in feet above sea level, measured on topographic maps by laying a grid over the map.
5. Storage—Area of lakes, ponds, and marshes, in percent of total drainage area, measured by planimetering or by using a transparent grid. The marsh area includes the area of wooded marshes and marshes as defined by the appropriate topographic quadrangle map symbol. Storage area is the total area of all the lakes, ponds, and marshes expressed as a percentage of the total drainage area.
6. Lake area—Area of lakes and ponds, in percent of the drainage area, determined by the grid method.
7. Forest—Area of forest, in percentage of the drainage area, determined from the forest cover as shown on the topographic map with the green woodland overprint using the grid method.
8. Soil—Soil index, in inches, represents the value of potential maximum infiltration, during an annual flood, under average soil-moisture conditions. This characteristic, provided by the U.S. Soil Conservation Service (Dr. Benjamin Isgur, written commun., 1970), is a function of the soil and cover conditions in the basin. The index was computed from the runoff curve number following procedures in U.S. Department of Agriculture (1972).
9. Latitude—Latitude of stream-gaging station, in decimal degrees, determined by manual measurement.
10. Longitude—Longitude of stream-gaging station, in decimal degrees, determined by manual measurement.
11. Precipitation—Mean-annual precipitation, in inches, determined from the isohyetal map in Knox and Nordenson (1955). The variation in mean-annual precipitation is shown in more detail in this map than in more recent sources.
12. Precipitation intensity--Maximum 24-hour rainfall, in inches, having a recurrence interval of 2 years. This characteristic was determined from U.S. Weather Bureau (1959b).
13. Snowfall—Average total seasonal snowfall, in inches, from an isohyetal map in Lautzenheiser (1969).
14. January temperature—Minimum January temperature, in degrees Fahrenheit, determined from U.S. Weather Bureau (1959a).

Several basin characteristics were measured following the grid method by using transparent grids to compute area or an average contour value. Storage area is determined by randomly placing the grid over the water and marsh area and counting squares. If the water and marsh area is large enough (about 30 squares), the number of grid intersections within the storage area are counted. The storage area then is computed as the product of the square size and the number of grid intersections. To measure a contour value such as elevation, the grid spacing is selected to give at least 25 intersections within the basin boundary. The elevation at each grid intersection is determined and an average is computed. The percentage of a variable that is extensive in a drainage basin, such as forest cover, can be easily measured by counting the number of grid intersections occurring over the forested area, multiplying by 100, and dividing by the number of grid intersections within the basin.

Streamflow Characteristics

Historic daily flow records available in the Blackstone River basin were used to compute daily, monthly, and annual flow characteristics. A summary of these records is given in table 2 and the location of streamflow sites is shown in figure 2. These flow data were collected as part of the Survey's nationwide data-collection network through agreements with State and Federal agencies. Records of daily flow are available from the Survey's National Water Data Storage and Retrieval System (WATSTORE). This water-data computer processing system consists of several files containing data grouped by common characteristic and data-collection frequency.

The WATSTORE system includes site identification, daily values files, and computer programs that produce streamflow statistics. Hydrologic-data files are maintained for (1) parameters measured on a daily or continuous basis, such as streamflow values, river stages, water temperatures, specific conductance values, and ground-water levels; (2) annual peak values for streamflow and stage; (3) chemical analyses for surface- and ground-water sites; and (4) ground-water site inventory, including location, identification and geohydrologic characteristics. The data-processing, storage, retrieval, and analysis capabilities of WATSTORE are described in the system user's guide compiled by Hutchison (1975). Information regarding the availability of data analyses may be obtained from: U.S. Geological Survey, 150 Causeway Street, Suite 1309, Boston, MA 02114.

A brief description of the streamflow statistics computed using the WATSTORE system is included below. Streamflow characteristics representing annual, monthly, and daily flow statistics were selected for this analysis because they are useful in planning and design studies in this region. The streamflow statistics computed following the procedures given below are listed in table 4 (at the end of the report).

Annual and monthly flow characteristics (means and standard deviations) were computed at six gaging stations with the "Daily Values Monthly and Annual Statistics" computer program W4422 (Price and Meeks, 1977) using observed daily flow records. The maximum and minimum, monthly means (fig. 3 and table 4) were obtained from output provided by this program. The monthly hydrograph for Quinsigamond River at Grafton is shown in figure 3.

Characteristics of the flow-duration curve (the daily flow exceeded 99, 95, 90, 75, 70, 50, 25, and 10 percent of the time) for six gaging stations were computed by means of computer program A969, "Daily Values Statistics" (Meeks, 1977). An example of a flow-duration curve for the Blackstone River at Northbridge is given in figure 4. Low-flow characteristics (annual 7-day mean low flows at the 2-year and 10-year recurrence intervals 7Q2 and 7Q10, respectively) at five gaging stations were also calculated by program A969. In this program, a log-Pearson Type III distribution is fitted to a set of observed annual 7-day mean low flows to obtain coordinates of the computed low-flow frequency curve. If the log-Pearson Type III curve did not adequately fit a plot of the observed data, especially in the low end, then a graphical curve was drawn. The graphical frequency curve was used to interpret the observed data when necessary because a graphical curve is the basic curve to use in analyzing the frequency of annual low flows according to Riggs (1971, 1972). The frequency curve for the Quinsigamond River at North Grafton is shown in figure 5.

Additional flow data, including flood-frequency analyses, are available from WATSTORE. Peak discharges for selected recurrence intervals for 82 sites in Massachusetts are given in Wandle (1982).

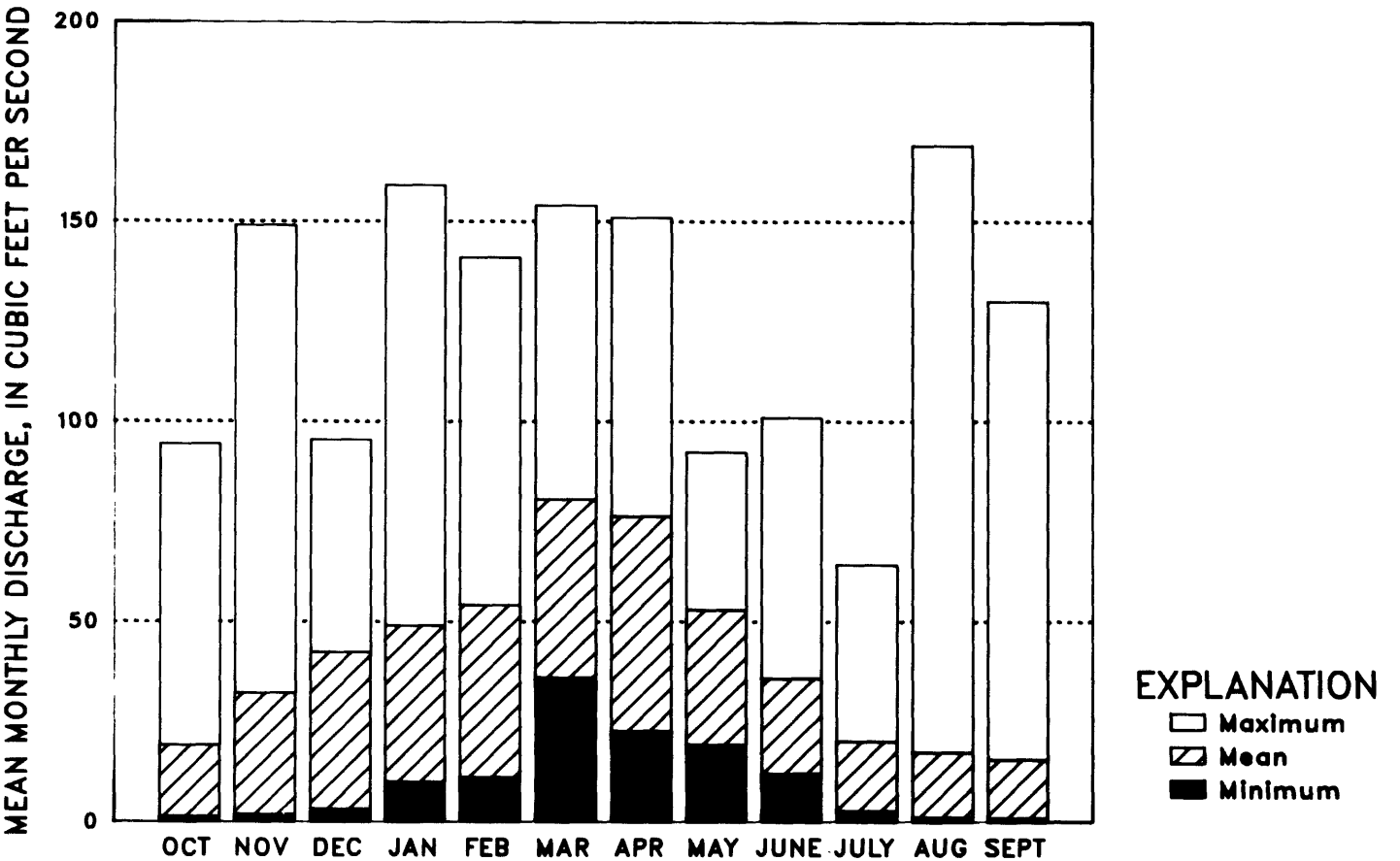

Figure 3.--Monthly discharges and extremes for Quinsigamond River at North Grafton, Mass. (site 10), during 1940-80

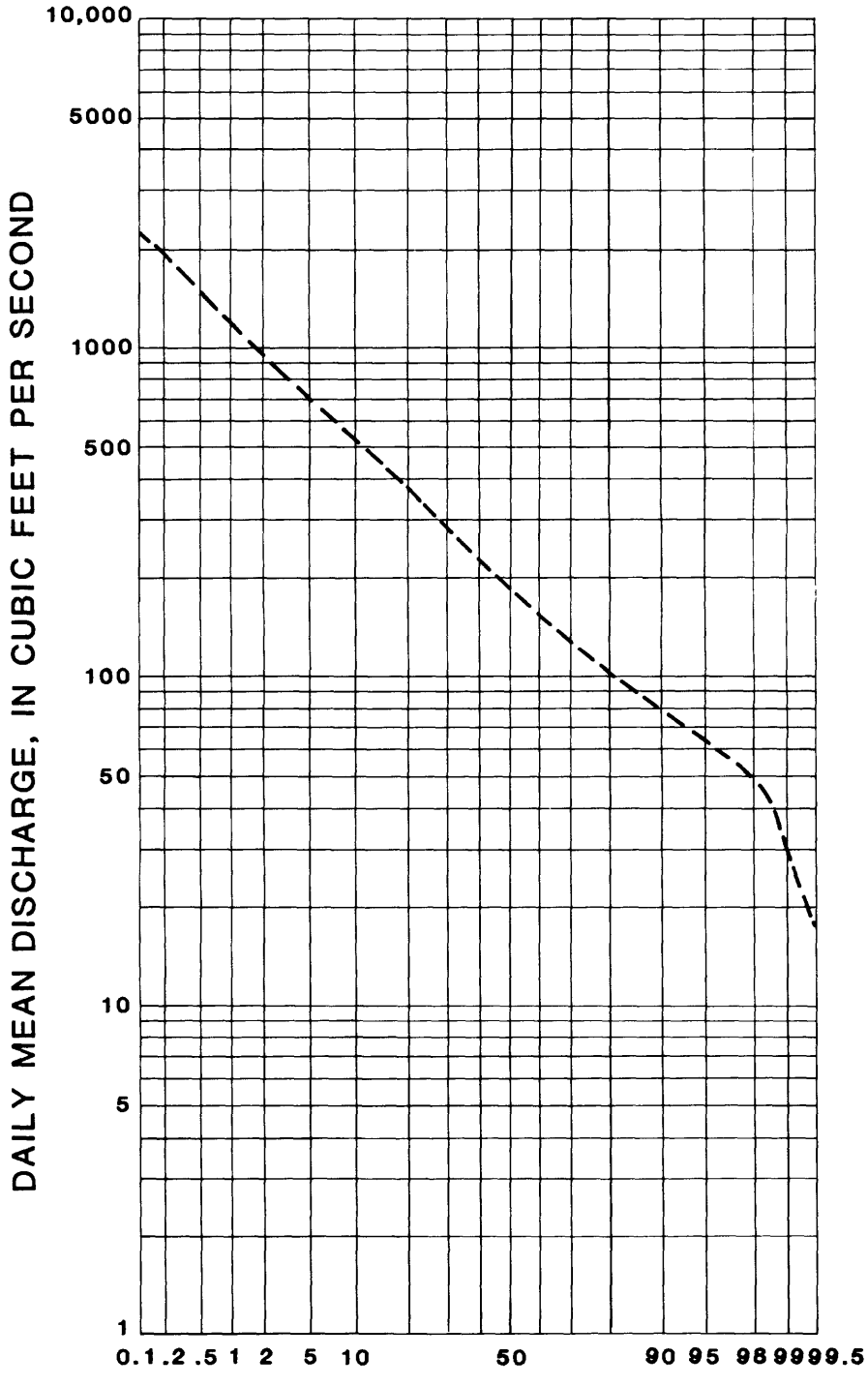

Figure 4.--Flow-duration curve for the Blackstone River at Northbridge, Mass. (site 11), during 1940-77

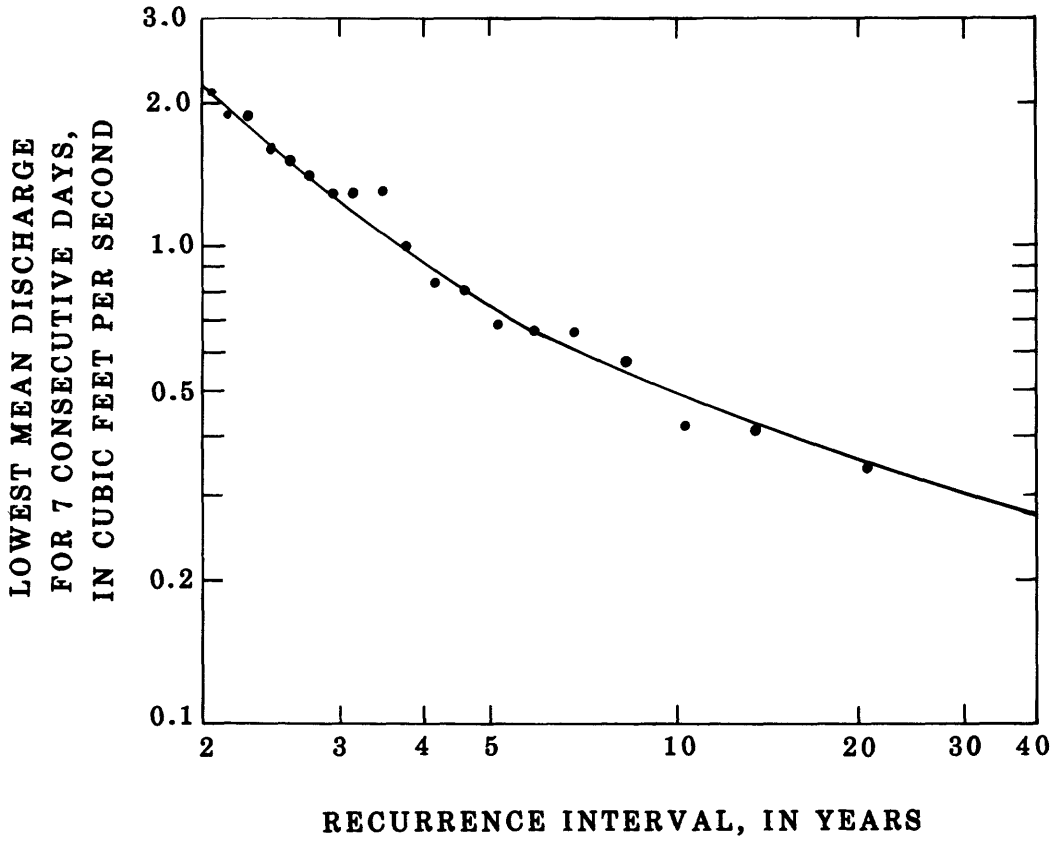

Figure 5.—Low-flow frequency curve for the Quinsigamond River at North Grafton, Mass. (site 10), during 1941-80

Characteristics of low flow were also determined at low-flow partial-record stations where measurements of discharge, rather than a continuous daily flow record, were available. This estimating technique is briefly described in the section on Streamflow Analysis. The 7-day low-flow statistics were developed from discharge measurements made during periods of base runoff. Base runoff is defined (Langbein and Iseri, 1960) as "the sustained or fair weather runoff. In most streams, base flow is composed largely of ground-water effluent." Base runoff usually occurs in most Massachusetts streams during the summer months or early fall after 5 to 7 consecutive days without rainfall.

STREAMFLOW ANALYSIS

Streamflow Data Base

Systematic records of daily streamflow have been collected since at least 1924 in the Blackstone River basin. The location and period of record for these gaging stations are given in table 2. Streamflow records are available for other sites in the Rhode Island portion of the basin from the U.S. Geological Survey office in Boston, Massachusetts.

Discharge measurements were made at 25 low-flow partial-record sites during the water-resources investigation of the Blackstone River basin (Walker and Krejmas, 1983). Measurements were also collected as part of the Massachusetts low-flow network at one site in 1978 and at one site during 1965. Data were collected on Massachusetts streams as part of the Rhode Island water-resources program in two tributary basins of the Blackstone River basin. Discharge measurements were made at four sites in the Branch River basin (Johnston and Dickerman, 1974b) and at site in the Abbott Run basin (Johnston and Dickerman, 1974a).

Flow characteristics are useful in resource management and design studies if these variables represent a particular regulated flow sequence or the natural flow regime that is expected to occur in the future. A valid streamflow analysis is based upon flow records during a period of relatively constant river-basin conditions.

Daily Flow Statistics

Systematic daily flow records available for six sites in the Blackstone River basin were reviewed to select a data base for statistical analysis. Impacts of reservoirs, diversions, regulation, and withdrawals for public supplies on streamflows were assessed using information on stream regulation found in the series of water-resources data reports issued annually (see U.S. Geological Survey, 1980, for an example) and in Knox and Soule (1949). Streamflow records for six sites were selected that represent a flow regime influenced by fairly constant river-basin conditions (Wandle, 1983). The record length used in this analysis is given in table 4. Low flow, monthly flow, and flow-duration characteristics given in table 4 were derived from the observed streamflow records at each station and are not adjusted for regulation or diversion. These daily streamflow characteristics were computed following procedures summarized in the section on streamflow characteristics.

Low-Flow Statistics

Continuous streamflow records are not necessary to estimate low-flow characteristics at sites. According to Riggs (1972) selected base-flow measurements rather than a continuous daily flow record can define the low-flow characteristics at a site.

Low-flow partial-record stations are operated to collect discharge measurements when streamflow is composed largely of ground-water runoff. These low-flow sites are selected on streams where flow is expected to occur during a significant dry spell and where the flow is not affected by artifical regulation. Base-flow measurements to define a relation with concurrent gaged flows are obtained over several low-flow periods.

A relation is developed with the base-flow measurements and the concurrent daily mean flows at a nearby long-record gaging station (index station). The 7-day low-flow statistics (7Q2 and 7Q10) for the site are determined from this relation using the appropriate low-flow statistics for the gaged stream. This estimating technique is explained in more detail by Riggs (1972).

The 7-day 10-year low-flow statistics for 31 sites in the Blackstone River basin are summarized in table 5 (at the end of the report). These low-flow statistics are representative of the hydrologic regime during the data-collection period. Seven-day 10-year low-flow statistics range from 0 to 0.14 $(ft^3/s)/mi^2$. Branch River at Forestdale and Nipmuc River near Harrisville, both in Rhode Island, and Sevenmile River near Spencer and Squannacook River near West Groton were used as the index stations. These values were computed following the procedures mentioned above.

SUMMARY

Drainage areas were computed for the first time for ungaged streams draining greater than 3 mi^2 and were re-computed for data-collection sites. Basin characteristics for drainage area, slope, length, elevation, lake area, soil, latitude, longitude, precipitation, precipitation intensity, snowfall, and January minimum temperature are provided for the five gaged sites in the Blackstone River basin. Computer programs A969 and W4422 were used to determine daily flow statistics including annual and monthly flows, duration of daily flows, and 7-day low-flow values. Seven-day 10-year low flows ranged from 0 to 0.14 $(ft^3/s)/mi^2$ at the 31 partial-record stations.

Techniques used to compute basin and streamflow characteristics of a river basin are summarized. This gazetteer contains a comprehensive listing of hydrologic characteristics that should prove useful to those concerned with water-resources activities.

Table 1.--Stream-order listing, selected drainage areas, and locations of subbasins within the Blackstone River basin

[Sites with streamflow information listed in tables 2, 4, or 5 are marked with an asterisk. The hierarchical listing is modified from Halliwell and others, 1982. Drainage areas are shown for sites as explained in the section on basin characteristics. These areas are not adjusted for manmade changes in the flow system. Streams entirely in adjacent states are underlined and are included in the list where necessary to maintain the stream order.]

Stream name	Location	Drainage area, in square miles
Blackstone River		
Abbott Run	Mendon Road	*24.7
Millers River		
Burnt Swamp Brook	Sumner Brown Road in Rhode Island	*4.68
Indian Brook		
Blackstone River tributary (R.I.)	0.5 mile upstream from mouth (Cass Park)	2.31a
Peters River	Paine Street	*11.8
Arnolds Brook		
Bungay Brook	Wrentham Street	*3.84
Bungay Brook	Wrentham Street	*2.62
Blackstone River	50 feet upstream from Peters River	[1] *416
Mill River	Harris Pond outlet (Mass.-R. I. State line)	33.2
Quick Stream	Mouth	2.01
Mill River	Forge Pond outlet	28.6
Hop Brook	Farm Street	*2.76
Mill River	Elm Street	*25.3
Round Meadow Brook	Mouth	1.05
Mill River	Bellingham Road	*19.1
Muddy Brook	Bellingham Road	*6.23
Spring Brook		
Ohio Brook	Mouth	.73
Willow Brook		
Mill River	Hopedale Pond outlet	10.3
Mill River	Hopedale Pond inlet	8.46
Mill River	State Route 140	*6.63
Mill River	Fiske Pond outlet	5.58
Unnamed tributary	North Pond outlet	2.86
Fox Brook	Mouth	4.07
Aldrich Brook		
Branch River (R.I.)	1.6 miles upstream from mouth	[1] *91.2
Nipmuc River (R.I.)		
Chockalog River	Brook Road	*4.15
Round Top Brook		
Round Top Brook tributary	Orange Street	*.22
Tinkerville Brook	Round Top Road	*5.15
Hemlock Brook		
Chase Pond tributary	Pine Street	*.77
Bating Brook	Pine Street	*1.38
Greene Brook		
Cedar Swamp Brook		

Table 1.—Stream-order listing, selected drainage areas, and locations of subbasins within the Blackstone River basin (Continued)

Stream name	Location	Drainage area, in square miles
Blackstone River	Dam 300 feet upstream from Mass.-R. I. State line	264
Blackstone River	400 feet upstream from railroad bridge	*263
Bacon Brook	Mouth	5.99
Card Machine Brook		
Unnamed tributary		
Aldrich Brook		
Emerson Brook	Mouth	7.55
Happy Hollow Brook		
Unnamed tributary		
Unnamed tributary		
Scadden Brook		
Unamed Brook		
Laurel Brook	Laurel Street	*1.95
West River		
Still Corner Brook	Blackstone Street	*1.28
Meadow Brook	Mouth	3.10
Wigwam Brook		
Rock Meadow Brook	Mouth	3.12
West River	250 feet downstream from West Hill Dam	*27.8
Taft Pond Brook	Upstream from Miscoe Brook	.69
Taft Pond Brook	Taft Pond outlet	1.00
Miscoe Brook		
Center Brook	Mouth	7.37
Center Brook	Mendon Street	*6.03
Center Brook	Unamed pond outlet	4.24
Center Brook	Hopkinton Road	*2.10
West River	Upstream from Center Brook	15.6
West River	Pleasant Street	*14.7
Warren Brook	Fowler Street	*3.81
Unnamed tributary		
Miscoe Brook	Stowe Road	4.49
Mumford River	Mouth	56.6
Unnamed tributary		
Cold Spring Brook	State Route 122	3.57
Farrel Brook		
Unnamed tributary		
Purgatory Brook		
Cook Allen Brook		
Steamburg Brook		
Mumford River	50 feet downstream from Lackey Dam	34.4
Dunleavey Brook		
Gilboa Brook		
Wellman Brook		
Mumford River	100 feet upstream from Manchaug Road	*29.1
Unnamed Brook		
Unnamed Brook		
Southwick Brook		

Table 1.—Stream-order listing, selected drainage areas, and locations of subbasins within the Blackstone River basin (Continued)

Stream name	Location	Drainage area, in square miles
Blackstone River (Continued)		
Mumford River (Continued)		
Centerville Brook	West Street	*3.74
Dudley Brook		
Riddle Brook		
Caswell Brook		
Mumford River		
Whitin Reservoir outlet	Mumford Street	*9.86
Whitin Reservoir outlet	Reservoir outlet	8.93
Unnamed tributary	Crystal Lake outlet	1.27
Unnamed tributary	Private road, 50 feet downstream from Wallis Pond outlet	2.62
Unnamed tributary	Tuckers Pond outlet	2.96
Dark Brook		
Unnamed tributary	Manchaug Road, 40 feet downstream from Stevens Pond outlet	7.55
Unnamed tributary	Torrey Road, 70 feet downstream from Manchaug Pond outlet	6.67
Unnamed tributary	Sutton Falls	2.75
Blackstone River	Upstream from Mumford River	148
Blackstone River	100 feet downstream from Sutton Street	*141
Quinsigamond River	Mouth	37.8
Axtell Brook		
Unnamed tributary		
Big Bummet Brook		
Quinsigamond River	Pleasant Street	36.0
Quinsigamond River	800 feet downstream from Hovey Pond	*25.6
Meadow Brook	Quinsigamond Road	1.94
West Brook	Main Street	*2.08
Coal Mine Brook		
Unnamed tributary		
Poor Farm Brook	Mouth	3.79
Sewall Brook	Mill Road Circle	*3.47
Cronin Brook	Folley Street	*2.83
Cold Spring Brook		
Cold Spring Brook tributary	State Route 122A	*.08
Cold Spring Brook	State Route 122A	*7.01
Unnamed tributary		
Casey Brook		
Unnamed tributary		
Dorothy Brook		
Broad Meadow Brook		
Singletary Brook	Mouth	5.84
Singletary Brook	Singletary Pond outlet	4.05
Blackstone River	U.S. Route 20	33.6
(Kettle Brook Diversion)		

Table 1.—Stream-order listing, selected drainage areas, and locations of subbasins within the Blackstone River basin (Continued)

Stream name	Location	Drainage area, in square miles
Blackstone River (Continued)		
Middle River		
Unnamed tributary		
Kettle Brook	75 feet downstream from Webster Street	*31.6
(Kettle Brook Diversion)		*--
Ramshorn Brook	State Route 12	*11.1
Dark Brook		
Ramshorn Brook	U.S. Route 20	7.44
Stone Brook		
Ramshorn Brook	Cartelon Road	4.19
Dark Brook	Dark Brook Reservoir outlet	2.67
Unnamed tributary		
Chapin Brook		
Kinnear Brook		
Lynde Brook		
Kettle Brook	Kettle Brook Reservoir No. 1 outlet	4.18
Beaver Brook		
Weasel Brook		
Unnamed tributary	Coes Reservoir outlet	11.4
Tatnuck Brook	Mower Street	7.48
The Cascade		
Tatnuck Brook	Holden Reservoir No. 2 outlet	5.23
Silver Spring Brook		
Scott Brook	South Road	*1.14
Wadsworth Brook		

[1] U.S. Geological Survey, 1980.
a Drainage basin is outside of Massachusetts.

Table 2.--Summary of daily flow records and peak-flow records available in the Blackstone River basin

Number in figure 2	Station number	Station name	Location	Period of record	Remarks
2	01109480	Kettle Brook Diversion Weir at Auburn, Mass.	Diversion weir	1979-80	(1)
3	01109500	Kettle Brook at Worcester, Mass.	75 feet downstream from Webster Street	1924-80	(2)
10	01110000	Quinsigamond River at North Grafton, Mass.	800 feet downstream from Hovey Pond	1940-80	(3)
11	01110500	Blackstone River at Northbridge, Mass.	100 feet downstream from Sutton Street	1940-80	(4)
14	01111000	Mumford River at East Douglas, Mass.	100 feet upstream from Manchaug Road	1940-51	(5)
19	01111200	West River below West Hill Dam near Uxbridge, Mass.	250 feet downstream from West Hill Dam	1963-80	(6)
22	01111230	Blackstone River at Millville, Mass.	400 feet upstream from railroad bridge	1970-80	(7)
33	01112300	Bungay Brook near Sheldonville, Mass.	Wrentham Street	1964-74	(8)
--	01111500	Branch River at Forestdale, R.I.	1.6 miles upstream from mouth	1941-80	(9)
36	01112500	Blackstone River at Woonsocket, R.I.	50 feet upstream from Peters River	1930-80	(10)

[1] Annual maximum flow through diversion tunnel. Diversions since 1959, usually during periods of high flow.
[2] Regulated by reservoirs. Regulation at low flow probably greater prior to 1938. Diversions for municipal use and through diversion tunnel. Record includes flow through tunnel prior to 1977. Daily record discontinued. Peak-flow site since 1978.
[3] Regulated by Lake Quinsigamond and by ponds.
[4] Regulated by mills and reservoirs. Regulation at low flow probably greater prior to 1952. Discharge includes diversions from Nashua River basin and Quabbin Reservoir at times since 1966. Miscellaneous measurement site since 1978.
[5] Regulated by mills and by ponds. Discontinued.
[6] Regulated by West Hill Dam.
[7] Water-quality monitor.
[8] Peak-flow site. Discontinued.
[9] Regulated by mills and reservoirs prior to 1957.
[10] Regulated by powerplants, by West Hill Reservoir since 1961, and by other reservoirs. Discharge includes diversions from Nashua River basin and from Quabbin Reservoir at times since 1966, and flow diverted around station in Hamlet Trench prior to 1964.

Table 3.—Basin characteristics for selected stream-gaging stations

Basin characteristics	Station number and site number					
	Kettle Brook at Worcester, Mass. (3)	Quinsigamond River at North Grafton, Mass. (10)	Blackstone River at Northbridge, Mass. (11)	Mumford River at East Douglas, Mass. (14)	Bungay Brook near Sheldon-ville, Mass. (33)	Blackstone River at East Woonsocket, R. I. (36)
Area, in square miles	31.6	25.6	141	29.1	2.62	[1]416
Slope, in feet per mile	--	18.6	24.8	32.0	36.3	11.5
Length, in miles	—	10.2	23.4	7.8	2.6	42.6
Elevation, in feet	--	496	611	637	330	500
Storage, in percent	—	—	--	—	22.7	—
Lake area, in percent	--	5.8	4.2	5.2	1.5	3.0
Forest, in percent	—	—	—	—	65	67
Soils index, in inches	--	5.24	4.44	5.29	5.9	5.5
Latitude of gage, in decimal degrees	42.2319	42.2303	42.1536	42.0733	42.0247	42.0061
Longitude of gage, in decimal degrees	71.8353	71.7114	71.6525	71.7161	71.4567	71.5036
Precipitation, in inches	--	44.0	44.0	44.0	45.0	44.2
Precipitation intensity for 2-year recurrence interval, in inches	--	3.2	3.3	3.5	3.5	3.4
Snowfall, in inches	—	53	55	52	50	52
January minimum temperature, in degrees Fahrenheit	—	18	17	18	18	17

[1] U.S. Geological Survey, 1980

Table 4.--Streamflow characteristics, in cubic feet per second, at selected stream-gaging stations

Annual and monthly flow characteristics:
QA is the mean annual discharge
SDQA is the standard deviation of mean annual discharge
QM is the mean discharge for M calendar month, M = 1 for January where the top line is the maximum mean; the middle line is the mean; the bottom line is the minimum mean
SDQM is the standard deviation of mean discharge for M calendar month

Low-flow characteristics:
7Q2 is the annual minimum 7-day mean discharge for 2-year recurrence interval
7Q10 is the annual minimum 7-day mean discharge for 10-year recurrence interval

Flow-duration characteristics:
DPT is the daily discharge, exceeded PT percent of the time, from the flow-duration curve

Years of record:
YRSDAY is the number of years of daily flow record for this analysis
YRSLOW is the number of years of low-flow record for this analysis

Flow	Station name and site number					
	Kettle Brook at Worcester, Mass. (3)	Quinsigamond River at North Grafton, Mass. (10)	Blackstone River at Northbridge, Mass. (11)	Mumford River at East Douglas, Mass. (14)	West River below West Hill Dam near Uxbridge, Mass. (19)	Blackstone River at East Woonsocket, R. I. (36)
ANNUAL						
QA	45.2	41.2	266	44.8	45.9	758
SDQA	15.4	12.2	72.9	10.5	13.6	204
MONTHLY						
Q10	170	94.3	438	39.3	53.9	2007
	24.3	19.1	157	27.1	16.7	398
	3.89	1.22	56.4	17.0	3.35	128
SDQ10	25.2	19.4	128	6.53	16.1	336
Q11	153	149	522	44.5	104	2233
	37.4	32.1	224	31.6	35.2	624
	7.13	1.80	67.7	15.3	3.30	127
SDQ11	31.2	28.2	157	9.75	32.1	474
Q12	128	95.4	603	75.2	136	2265
	44.6	42.3	266	39.5	53.0	821
	.77	3.07	86.9	16.6	4.96	186
SDQ12	30.5	23.3	139	18.6	36.7	504

Table 4.--Streamflow characteristics, in cubic feet per second, at selected stream-gaging stations (Continued)

Flow	Station name and site number					
	Kettle Brook at Worcester, Mass. (3)	Quinsigamond River at North Grafton, Mass. (10)	Blackstone River at Northbridge, Mass. (11)	Mumford River at East Douglas, Mass. (14)	West River below West Hill Dam near Uxbridge, Mass. (19)	Blackstone River at East Woonsocket, R. I. (36)
MONTHLY (Continued)						
Q1	115	159	549	84.1	148	3167
	49.3	49.0	282	49.5	59.9	961
	9.73	9.85	93.8	9.27	7.86	203
SDQ1	27.7	29.8	128	23.2	39.5	553
Q2	109	141	832	137	159	2493
	51.0	54.1	324	60.1	70.0	958
	20.8	11.0	153	15.3	13.4	262
SDQ2	23.2	25.8	141	30.4	45.7	425
Q3	303	154	1072	139	206	4063
	94.7	80.6	515	80.2	105	1537
	35.9	35.9	250	33.0	70.5	740
SDQ3	46.7	25.0	172	30.8	35.2	598
Q4	222	151	923	110	180	2520
	89.7	76.3	475	65.8	95.8	1404
	21.4	22.5	192	41.5	33.3	479
SDQ4	46.5	30.1	201	20.0	33.9	534
Q5	106	92.3	608	99.1	118	1179
	51.1	52.9	303	62.4	54.5	873
	16.3	19.2	123	31.5	24.3	303
SDQ5	25.4	19.2	118	21.1	21.5	330
Q6	123	101	661	81.6	125	1847
	33.6	35.8	225	48.2	30.2	558
	9.65	12.0	98.4	21.9	7.68	181
SDQ6	25.3	22.5	121	19.5	27.3	342
Q7	153	64.2	428	44.9	47.1	2453
	21.3	20.0	142	26.4	14.0	330
	6.99	2.67	58.4	14.6	3.03	125
SDQ7	22.6	14.5	76.8	8.63	12.8	340

Table 4.--Streamflow characteristics, in cubic feet per second, at selected stream-gaging stations (Continued)

Flow	Station name and site number					
	Kettle Brook at Worcester, Mass. (3)	Quinsigamond River at North Grafton, Mass. (10)	Blackstone River at Northbridge, Mass. (11)	Mumford River at East Douglas, Mass. (14)	West River below West Hill Dam near Uxbridge, Mass. (19)	Blackstone River at East Woonsocket, R. I. (36)
MONTHLY (Continued)						
Q8	257	169	1195	32.8	35.8	2704
	21.2	17.3	145	24.7	9.75	302
	6.09	1.05	51.2	11.6	2.14	111
SDQ8	33.6	25.8	180	6.72	9.10	367
Q9	156	130	805	34.8	18.6	1980
	24.5	15.5	146	24.7	7.34	340
	5.16	.84	56.8	14.4	2.33	113
SDQ9	26.7	20.7	124	6.09	4.58	316
LOW-FLOW						
7Q2	8.5	2.2	72	—	2.8	134
7Q10	4.9	.48	45	—	1.5	101
FLOW DURATION						
D99	4.6	.81	30.0	6.6	2.0	93.0
D95	7.8	11.0	62.0	11	2.9	130
D90	9.5	15.0	77.0	15	3.8	160
D75	14.7	22.5	111	22.5	8.6	249
D70	16.6	25.1	124	25.1	11.3	287
D50	27.6	37.0	188	37	27.6	523
D25	56.1	56.8	335	56.8	61.9	987
D10	102	86.4	558	86.4	114	1660
YEARS						
YRSDAY	54	41	38	13	19	52
YRSLOW	40	40	25	—	18	28

Table 5.--Summary of 7-day low-flow characteristics, drainage area, and period of record for low-flow partial-record stations

(A dash indicates insufficient data are available to define 7Q10.)

Number in figure 2	Station number	Station name	Location	Period of record	Drainage area, in square miles	Estimated annual minimum 7-day mean low flow, in cubic feet per second, at 10-year recurrence interval
1	01109460	Ramshorn Book at Auburn, Mass.	State Route 12	1978-79	11.1	1.6
4	01109540	Scott Brook near Paxton, Mass.	South Road	1978-79	1.14	.0
5	01109850	Cold Spring Brook at Wilkinsonville, Mass.	State Route 122A	1979	7.01	—
6	01109851	Cold Spring Brook tributary at Wilkinsonville, Mass.	State Route 122A	1978	.08	—
7	01109870	Cronin Brook at Wilkinsonville, Mass.	Folley Street	1978	2.83	.0
8	01109920	Sewall Brook at Morningdale, Mass.	Mill Road Circle	1978	3.47	.4
9	01109950	West Brook at Shrewsbury, Mass.	Main Street	1978	2.08	.0
12	01110995	Whitin Reservoir Outlet at Manchaug, Mass.	Mumford Street	1978-79	9.86	—
13	01110998	Centerville Brook at East Douglas, Mass.	West Street	1978	3.74	—
14	01111000	Mumford River at East Douglas, Mass.	100 feet upstream from Manchaug Road	[1]1978	29.1	—

Table 5.--Summary of 7-day low-flow characteristics, drainage area, and period of record for low-flow partial-record stations (Continued)

Number in figure 2	Station number	Station name	Location	Period of record	Drainage area, in square miles	Estimated annual minimum 7-day mean low flow, in cubic feet per second, at 10-year recurrence interval
15	01111130	Warren Brook near West Upton, Mass.	Fowler Street	1978	3.81	0.0
16	01111150	West River at West Upton, Mass.	Pleasant Street	1978	14.7	.5
17	01111160	Center Brook at Upton, Mass.	Hopkinton Road	1978	2.10	—
18	01111170	Center Brook at Mendon Street, Upton, Mass.	Mendon Street	1978-79	6.03	<.1
20	01111210	Still Corner Brook near Uxbridge, Mass.	Blackstone Street	1978	1.28	.0
21	01111220	Laurel Brook near Uxbridge, Mass.	Laurel Street	1978	1.95	.1
23	01111272	Bating Brook near Douglas, Mass.	Pine Street	1968, 1978	1.38	.0
24	01111273	Chase Pond tributary near Douglas, Mass.	Pine Street	1968	.77	.0
25	01111275	Tinkerville Brook near Douglas, Mass.	Round Top Road	1968, 1978-79	5.15	<.1
26	01111277	Round Top Brook near Douglas, Mass.	Orange Street	1968	.22	.0
27	01111290	Chockalog River near Harrisville, R.I.	200 feet downstream from Brook Road	1968	4.15	.0
28	01112100	Mill River near Milford, Mass.	State Route 140	1978	6.63	.2

Table 5.--Summary of 7-day low-flow characteristics, drainage area, and period of record for low-flow partial-record stations (Continued)

Number in figure 2	Station number	Station name	Location	Period of record	Drainage area, in square miles	Estimated annual minimum 7-day mean low flow, in cubic feet per second, at 10-year recurrence interval
29	01112190	Muddy Brook at South Milford, Mass.	Bellingham Road	1978	6.23	0.3
30	01112200	Mill River at South Milford, Mass.	Bellingham Road	1978-79	19.1	.7
31	01112250	Mill River near Blackstone, Mass.	Elm Street	1978	25.3	1.5
32	01112260	Hop Brook near Blackstone, Mass.	Farm Street	1978	2.76	—
33	01112300	Bungay Brook near Sheldonville, Mass.	Wrentham Street	[2]1965	2.62	—
34	01112350	Bungay Brook at Crooks Corner, Mass.	Wrentham Street	1978-79	3.84	<.1
35	01112380	Peters River at Crooks Corner, Mass.	Paine Street	1978-79	11.8	.7
37	01113670	Burnt Swamp Brook near Grant Mills, R.I.	Sumner Brown Rd.	1978	4.68	.0
38	01113750	Abbott Run near South Attleboro, Mass.	Mendon Road	1970	24.7	—

[1] Daily flow record 1940-51.
[2] Peak-flow site 1964-74.

SELECTED REFERENCES

Benson, M. A., 1962, Factors influencing the occurrence of floods in a humid region of diverse terrain: U.S. Geological Survey Water-Supply Paper 1580B, 64 p.

Brackley, R. A. and Wandle, S. W., Jr., 1982, Drainage divides, Massachusetts--Nashua and Concord River basins: U.S. Geological Survey Open-File Report 82-924, 22 maps.

Halliwell, D. B., Kimball, W. A., and Screpetis, A. J., 1982, Massachusetts stream classification program, part I, Inventory of rivers and streams: Massachusetts Department of Environmental Quality Engineering and Department of Fisheries, Wildlife, and Recreational Vehicles, 126 p., appendix consisting of 3 pages.

Higgins, G. R., 1967, Yield of streams in Massachusetts: Amherst, Massachusetts, University of Massachusetts, Water Resources Research Center Publication 5, 175 p.

Hutchison, N. E., compiler, 1975, WATSTORE--National water data storage and retrieval system of U.S. Geological Survey—User's guide: U.S. Geological Survey Open-File Report 75-426, 791 p. (revised).

Johnson, C. G., 1970, A proposed streamflow data program for central New England: U.S. Geological Survey open-file report, 38 p., 1 appendix consisting of 11 pages.

Johnson, C. G., and Tasker, G. D., 1974, Progress report on flood magnitude and frequency of Massachusetts streams: U.S. Geological Survey Open-File Report 74-131, 41 p.

Johnston, H. E., and Dickerman, D. C., 1974a, Availability of ground water in the Blackstone River area, Rhode Island and Massachusetts: U.S. Geological Survey Water Resources Investigations 4-74, 2 pl.

_____1974b, Availability of ground water in the Branch River area, Rhode Island and Massachusetts: U.S. Geological Survey Water Resources Investigations 18-74, 39 p., 1 pl.

Knox, C. E., and Nordenson, T. J., 1955, Average annual runoff and precipitation in the New England-New York area: U.S. Geological Survey Hydrologic Investigations Atlas 7, 6 p.

Knox, C. E., and Soule, R. M., 1949, Hydrology of Massachusetts, part 1, Summary of streamflow and precipitation records: U.S. Geological Survey Water-Supply Paper 1105, 240 p.

Krejmas, B. E., 1982, Drainage divides, Massachusetts—Blackstone and Thames River basins: U.S. Geological Survey Open-File Report 82-631, 12 maps.

Langbein, W. B. and Iseri, K. T., 1960, General introduction and hydrologic definitions, in Manual of hydrology, part 1, General surface-water techniques: U.S. Geological Survey Water-Supply Paper 1541-A, p. 1-29.

Langbein, W. B., and others, 1947, Topographic characteristics of drainage basins: U.S. Geological Survey Water-Supply Paper 968-C, p. 125-157.

Lautzenheiser, R. E., 1969, Snowfall, snowfall frequencies, and snow cover data for New England: Environmental Sciences Services Administration Technical Memorandum EDSTM 12, 15 p.

Male, J. W., and Ogawa, H., 1982, Low flows of Massachusetts streams: Amherst, Massachusetts, University of Massachusetts, Water Resources Research Center Publication 125, 152 p.

Meeks, W. C., 1977, Daily values statistics (program A969), in Hutchison, N. E., compiler, 1975, WATSTORE--National water data storage and retrieval system of the U.S. Geological Survey user's guide: U.S. Geological Survey Open-File Report 75-426 (revised), chap. IV, section G.

Price, W. E., Jr., and Meeks, W. C., 1977, Daily values monthly and annual statistics (program W4422), in Hutchison, N. E., compiler, 1975, WATSTORE--National water data storage and retrieval system of the U.S. Geological Survey user's guide: U.S. Geological Survey Open-File Report 75-426 (revised), chap. IV, section F.

Riggs, H. C., 1971, Discussion of probability distribution of annual droughts by Eratakulan S. Joseph: American Society of Civil Engineers Proceedings, v. 97, no. IR3, p. 540-541.

_____1972, Low-flow investigations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 4, chap. B1, 18 p.

Thomas, D. M., and Benson, M. A., 1970, Generalization of streamflow characteristics from drainage-basin characteristics: U.S. Geological Survey Water-Supply Paper 1975, 55 p.

U.S. Department of Agriculture, 1972, Soil Conservation Service National Engineering Handbook, section 4, Hydrology: U.S. Department of Agriculture, Soil Conservation Service.

U.S. Federal Inter-Agency River Basin Committee, Subcommittee on Hydrology, 1951, Interagency coordination of drainage area data, notes on hydrologic activities: Water Resources Council, Subcommittee on Hydrology Bulletin no. 4, 48 p.

U.S. Geological Survey, 1977, National handbook of recommended methods for water-data acquisition: U.S. Geological Survey, chap. 7, 38 p.

_____1980, Water resources data for Massachusetts and Rhode Island, water year 1979: U.S. Geological Survey Water-Data Report MA-RI-79-1, 349 p.

U.S. Weather Bureau, 1959a, Climates of the states, Massachusetts: U.S. Weather Bureau, Climatography of the United States, Paper No. 60-19, 20 p.

_____1959b, Rainfall intensity-frequency regime, northeastern United States: U.S. Weather Bureau Technical Paper no. 29, 35 p.

Walker, E. H., and Krejmas, B. E., 1983, Water resources in the Blackstone River basin, Massachusetts: U.S. Geological Survey Open-File Report 83-700, 37 p.

Wandle, S. W., Jr., 1982, Estimating peak discharges of small, rural streams in Massachusetts: U.S. Geological Survey Open-File Report 80-676, 33 p.

_____1983, Low-flow frequency and flow-duration analysis of natural-flow streams in Massachusetts: Boston Society of Civil Engineers Section Journal, v. 69, no 1, p. 87-110.

_____1984a, Gazetteer of hydrologic characteristics of streams in Massachusetts—coastal river basins of the North Shore and Massachusetts Bay: U.S. Geological Survey Water-Resources Investigations Report 84-4281.

_____1984b, Gazetteer of hydrologic characteristics of streams in Massachusetts—Connecticut River basin: U.S. Geological Survey Water-Resources Investigations Report 84-4282.

_____1984c, Gazetteer of hydrologic characteristics of streams in Massachusetts—Hudson River basin: U.S. Geological Survey Water-Resources Investigations Report 83-4250.

Wandle, S. W., Jr., and Fontaine, R. A., 1984, Gazetteer of hydrologic characteristics of streams in Massachusetts--Merrimack River basin: U.S. Geological Survey Water-Resources Investigations Report 84-4284.

Wandle, S. W., Jr., and Frimpter, M. H., 1982, Drainage divides, Massachusetts--Taunton River basin and southeast coastal basins: U.S.Geological Survey Open-File Report 82-870, 24 maps.

Wandle, S. W., Jr., and Keezer, G. R., 1984, Gazetteer of hydrologic characteristics of streams in Massachusetts--Taunton and Ten Mile River basins and coastal river basins of Mount Hope Bay, Narragansett Bay, and Rhode Island Sound: U.S. Geological Survey Water-Resources Investigations Report 84-4283.

Wandle, S. W., Jr., and LeBlanc, J. A., 1984, Gazetteer of hydrologic characteristics of streams in Massachusetts--Thames River basin: U.S. Geological Survey Water-Resources Investigations Report 84-4287.

Wandle, S. W., Jr., and Lippert, R. G., 1984, Gazetteer of hydrologic characteristics of streams in Massachusetts--Housatonic River basin: U.S. Geological Survey Water-Resources Investigations Report 84-4285.

Wandle, S. W., Jr., and Morgan, M. A., 1984, Gazetteer of hydrologic characteristics of streams in Massachusetts--coastal river basins of the South Shore and Buzzards Bay: U.S. Geological Survey Water-Resources Investigations Report 84-4288.