

CONTENTS

Abstract	1
Introduction	2
Purpose and Scope	2
Previous Studies	3
Physical Setting	6
Acknowledgments	7
Estimating Methods for Data-Collection Stations	7
Low-Flow Statistics for Streamgaging Stations	7
Flow-Duration Statistics	8
Low-Flow Frequency Statistics	8
August Median Flows	9
Streamflow Statistics for Streamgaging Stations with Short Records	9
Low-Flow Statistics for Low-Flow Partial-Record Stations	9
Mathematical Method	9
Graphical Method	11
Combining Estimates Determined from Multiple Index Sites	11
Estimating Methods for Ungaged Stream Sites	14
Drainage-Area Ratio Method	14
Regression Equations	26
Data Base Development	28
Development of the Equations	31
Weighting Procedure	32
Prediction Intervals	34
Example Computations	34
Limitations for Use of the Equations	36
World Wide Web Application for Use of the Equations	36
Combining Estimates Determined by Different Methods	37
Summary	38
References Cited	39

FIGURES

1. Map showing locations of streamgaging stations and low-flow partial-record stations used to develop equations for estimating low-flow statistics for ungaged Massachusetts streams and locations of streamgaging stations outside Massachusetts used for correlation with low-flow partial-record stations, and boundaries of the 27 major river basins and three hydrologic regions in the State	4
2, 3. Graph showing:	
2. Example MOVE.1 relation between a low-flow partial-record station, Hemlock Brook near Williamstown, Mass., and a streamgaging station, Green River at Williamstown, Mass.	10
3. Example graphical relation between a low-flow partial-record station, Hopping Brook near West Medway, Mass., and a streamgaging station, West River near Uxbridge, Mass.	11
4. Maps showing locations and drainage boundaries of low-flow partial-record stations and gaging stations in the (A) Squannacook, (B) Wading, (C) Quaboag, (D) Green, and (E) West Branch Westfield River Basins	16
5. Relation of drainage-area ratio to average absolute percent difference in streamflow statistics between data-based estimates and estimates derived from the drainage-area ratio method, and from the regression equations	24

TABLES

1. Descriptions of low-flow partial-record and streamgaging stations used to analyze the applicability of the drainage-area ratio method for estimating streamflow statistics for ungaged Massachusetts streams.....	21
2. Medians and standard deviations of absolute percent differences between streamflow statistics estimated using available data and by using the drainage area ratio method and regression equations.....	25
3. Descriptions of streamgaging stations used in the regression analyses or for correlation with low-flow partial-record stations, or both.....	29
4. Summary of regression equations developed for estimating low-flow statistics for Massachusetts streams	32
5. Values needed to determine 90-percent prediction intervals for estimates obtained from the equations	35
6. Ranges of basin characteristics used to develop the regression equations.....	36
7. Low-flow statistics estimated using available data, the drainage-area ratio method, and regression equations; and absolute percent differences between the data-based estimates and estimates from the drainage-area ratio method and regression equations for stations used to analyze to applicability of the drainage-area ratio method for estimating low-flow statistics for ungaged Massachusetts streams	45
8. Descriptions of low-flow partial-record stations used in the regression analyses	55
9. Streamflow statistics, variances, standard errors, and years of record for stations included in the regression analyses.....	59
10. Basin characteristics for stations used in the regression analyses	77

CONVERSION FACTORS. VERTICAL DATUM, ACRONYMS AND ABBREVIATIONS

CONVERSION FACTORS

Multiply	By	To obtain
cubic foot (ft ³)	0.02832	cubic meter
cubic feet per second (ft ³ /s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
inch (in)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi ²)	2.590	square kilometer
Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) as follows: $^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$		

VERTICAL DATUM

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

ACRONYMS AND ABBREVIATIONS

Organizations

MOWR	Massachusetts Department of Environmental Management, Division of Resource Conservation, Office of Water Resources
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service

Basin Characteristics

DA	Drainage area, in square miles
DR	Area of stratified-drift deposits, in square miles
DR/ST	Area of stratified drift per unit stream length
SLOPE	Mean basin slope, in percent
REG	Region, 0 in eastern Massachusetts, 1 in western Massachusetts

Miscellaneous

AML	A programming language for automating tasks with the Arc/Info GIS software developed by the Environmental Systems Research Institute, Inc.
BCF	Bias correction factor
DEM	Digital elevation model of topography
GIS	Geographic information system computer software
GLS	Generalized-least-squares regression analysis
LFPR	Low-flow partial-record station
OLS	Ordinary-least-squares regression analysis
MAD	Median absolute deviation, in percent
MOVE.1	Maintenance of variance extension, type 1, method of correlation
MSE	Mean square error of regression
MVUE	Minimum variance unbiased estimate of retransformation bias correction
PRESS	Prediction error sum of squares
WLS	Weighted-least-squares regression analysis