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Assessment of Channel Geometry Data through May 2003 in the Mid-Atlantic Highlands of Maryland, Pennsylvania, Virginia, and West Virginia

Open File Report 03-388

U.S. Department of the Interior
U.S. Geological Survey

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By Kimberly F. Miller

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CANAAN VALLEY INSTITUTE AND THE WEST VIRGINIA DEPARTMENT OF TRANSPORTATION, DIVISION OF HIGHWAYS

Charleston, West Virginia
2003

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Cover photo—Hemlock-shaded natural stream channel in West Virginia. Printed with permission from Dawn Newell, Charleston, WV.

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CONVERSION FACTORS

Multiply	By	To Obtain
square mile (mi^2)	2.590	square kilometer

Assessment of Channel-Geometry Data through May 2003 in the Mid-Atlantic Highlands of Pennsylvania, Maryland, Virginia, and West Virginia

By Kimberly F. Miller

ABSTRACT

Bankfull channel-geometry relations, also called regional curves, relate bankfull stream-channel dimensions to watershed drainage area. This study describes available channel-geometry data from four published reports and one unpublished document for the Mid-Atlantic Highlands of Pennsylvania, Maryland, Virginia, and West Virginia. The assessment is limited to data available through May, 2003. Available data was assessed against specified criteria including streams having 10 years or more of annual-peak data, representing drainage areas of less than 250 square miles, with less than 20-percent urbanization, and without streamflow regulation. The annual-peak data were further assessed, to minimize effects of land-use changes.

A streamflow gaging network was determined for stations that could be used to develop regional curves in the Mid-Atlantic Highlands. There is a lack of information available for gages with drainage areas less than one square mile. This poses a problem since many restoration projects that need regional curve information are on small streams.

INTRODUCTION

Stream-channel morphology is controlled by physical characteristics within a basin that vary over time. The morphology of the stream will tend toward equilibrium unless catastrophic natural events occur or the basin is disturbed by human activities. Often stream channels are disturbed by events such as these. In recent years the principles of fluvial geomorphology have been used in the construction and restoration of stream channels. Stream channels designed to approximate natural, stable conditions are more likely to remain in equilibrium. These natural, stable conditions are partially determined by measuring the relationships among selected basin, flow, and channel-geometry characteristics.

Bankfull discharge is considered to be the streamflow magnitude that is most effective in forming average morphological characteristics of channels (Dunne and Leopold, 1978). Bankfull channel-geometry relations relate bankfull stream-channel dimensions to watershed drainage area. Once these relations are determined, they are plotted to form a curve. Such a curve may be applied to other streams with similar environmental settings within the defined region. This relation is known as a regional curve. Regional relations between bankfull discharge and the resultant channel-geometry or morphological characteristics, including bankfull cross-sectional area, width, and average depth at stream riffle sections, are important tools for designing and restoring stable stream channels. Studies have shown that bankfull channel-geometry characteristics of cross-sectional area, width, and average depth are highly correlated with drainage area (Dunne and Leopold, 1978).

The primary purpose for developing regional curves is to aid in identifying bankfull stage and dimension in an ungaged watershed and to help estimate the bankfull dimensions and discharge for natural channel designs. Although, channel-geometry relations or curves can be determined for individual projects, a more economical and possibly more representative approach is to develop curves representing regional conditions. These regional curves should have broad applications in the areas they represent.

Purpose and Scope

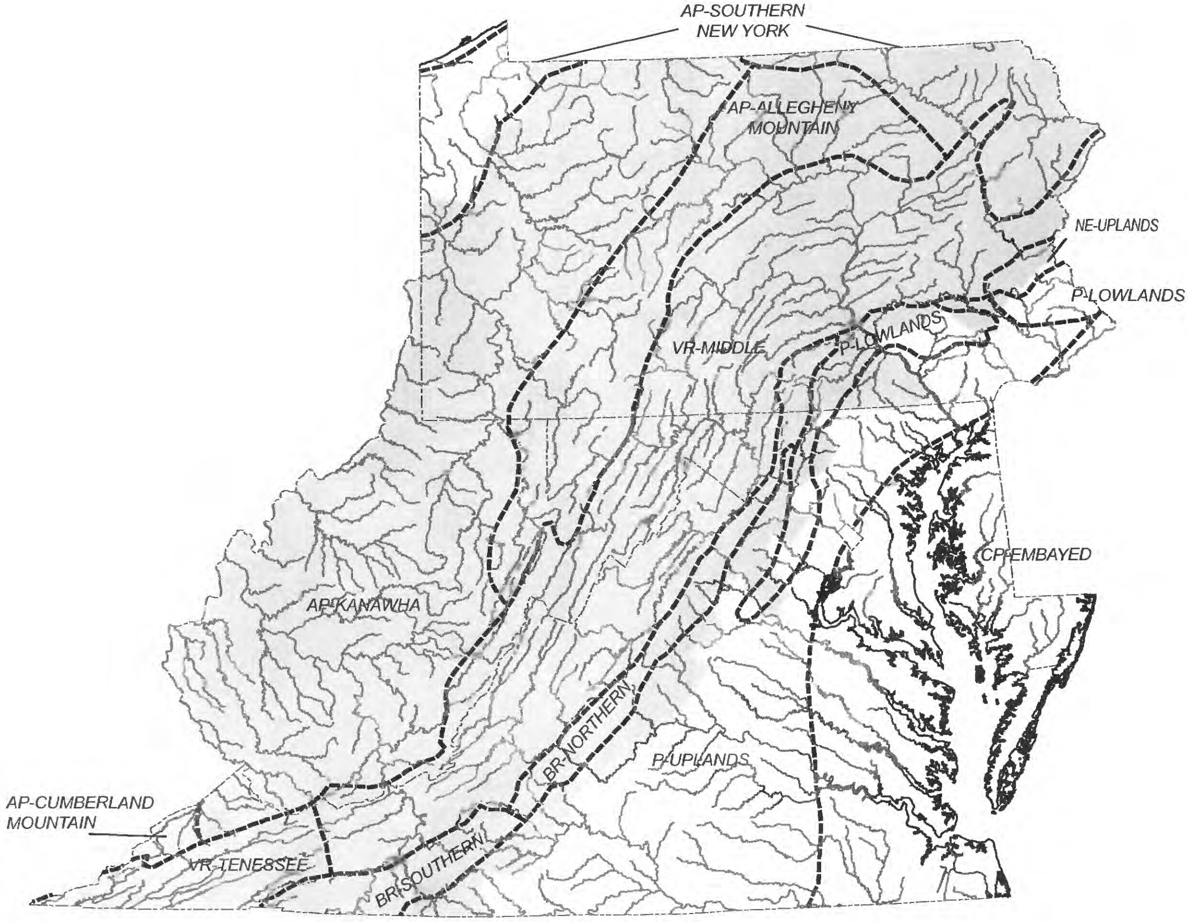
This report includes a compilation and evaluation of available channel-geometry data, regional curves, and metadata developed by the U.S. Geological Survey (USGS) and other entities for the Mid-Atlantic Highlands in Pennsylvania, Maryland, Virginia, West Virginia, and adjacent areas. Assessments of data are limited to information available through May 2003. This report also evaluates USGS stream-gaging networks for use in calibrating regional channel geometry curves within the study area.

Description of the Study Area

The study area discussed in this report consists of the Mid-Atlantic Highlands (Corey Anderson, Canaan Valley Institute, written commun., 2003) and includes most of Pennsylvania, western areas of Maryland and Virginia, and all of West Virginia (fig. 1). The Mid-Atlantic Highlands includes areas in the Appalachian Plateaus, Coastal Plain, Valley and Ridge, Blue Ridge, and Piedmont Physiographic Provinces (Fenneman 1938).

ASSESSMENT METHODS AND CRITERIA

Methods used to assess available channel-geometry data include a search of the world-wide web, verbal and written requests for information, and review of historical data from USGS gaging stations. A web search found data and results of completed and ongoing regional-curve studies in the Mid-Atlantic Highlands. In addition to the web search, an information request was sent to 78 entities identified as potentially having regional-curve data (table 1). Requested information included gage-selection criteria, calibration methodology, QA/QC (quality assurance and quality control) procedures, documentation for the data compiled, and the name of the organization that collected the data.



Map data sources: Physiographic Provinces and Sections: Fenneman (1938):
Mid-Atlantic Highlands boundary: Corey Anderson (Canaan Valley Institute, written commun., 2003).

EXPLANATION

MAJOR STREAMS

PHYSIOGRAPHIC PROVINCES AND SECTIONS

POLITICAL BOUNDARIES

State

Coastal

MID-ATLANTIC HIGHLANDS

0 25 50 100 MILES

0 25 50 100 KILOMETERS

PHYSIOGRAPHIC PROVINCE ABBREVIATIONS:
AP = Appalachian Plateaus *BR = Blue Ridge*
CP = Coastal Plain *NE = New England*
VR = Valley and Ridge *P = Piedmont*

STUDY AREA LOCATION

Figure 1. Location of the Mid-Atlantic Highlands physiographic provinces and sections in Maryland, Pennsylvania, Virginia, and West Virginia.

Table 1. Agencies and institutions contacted for Mid-Atlantic Highlands channel-geometry data as a result of the web search for all data prior to May 2003

Name of agency or institution
COLORADO
Bureau of Reclamation (WV Data)
MARYLAND
Alliance for the Chesapeake Bay
Biohabitats Inc.
Brightwater Inc.
Coastal and Watershed Resources Division
Environmental Concern Inc.
Environmental Projects Division-State Highways Administration
Environmental Quality resources, LLC
Environmental Systems Analysis Inc.
Fish, Heritage and Wildlife Administration
Frederick County Division of Public Works
Interstate Commission on the Potomac River Basin
Maryland Department of the Environment
Maryland Department of Natural Resources
Maryland Society of Professional Engineers
Natural Resources Management Program
Smithsonian Environmental Research Center
Straughan Environmental Service, Inc.
University of Maryland
Versar, Inc.
Maryland Water Resources Research Center
MASSACHUSSETS
Coastal Hydraulics Laboratory
NORTH CAROLINA
Appalachian Environmental Services
Cape Fear River Assembly, Inc.
Eno River Association
North Carolina Department of Environment and Natural Resources
North Carolina Division of Water Quality
North Carolina State University
Roanoke River Partners
Southern Research Station
The Nature Conservancy
Water Resources Research Institute of the University of North Carolina

Table 1. Agencies and institutions contacted for Mid-Atlantic Highlands channel-geometry data as a result of the web search for all data prior to May 2003--Continued

Name of agency or institution
PENNSYLVANIA
Alliance for the Chesapeake Bay
Land Studies, Inc.
Pennsylvania Bureau of Land and Water Conservation
Pennsylvania Conservation Corps
Pennsylvania Cooperative Fish and Wildlife Research Unit
Pennsylvania Department of Community Affairs
Pennsylvania Department of Environmental Resources
Pennsylvania Fish & Boat Commission
Penn State University
VERMONT
University of Vermont
VIRGINIA
Alliance for the Chesapeake Bay
American Water Resources Association
Anderson & Associates Inc.
Biohabitats Inc.
City of Fairfax, Virginia
Friends of the North Fork of the Shenandoah River
Friends of the Shenandoah River
Randolph-Macon College
Roanoke College
Thomas Jefferson Planning District Commission
University of Virgina
Virginia Association of Soil and Water Conservation Districts
Virginia Department of Conservation and Recreation
Virginia Department of Environmental Quality
Virginia Department of Forestry
Virginia Department of Game and Inland Fisheries
Virginia Department of Transportation
Virginia Tech University
Virginia Water Resources Research Center
Washington and Lee University

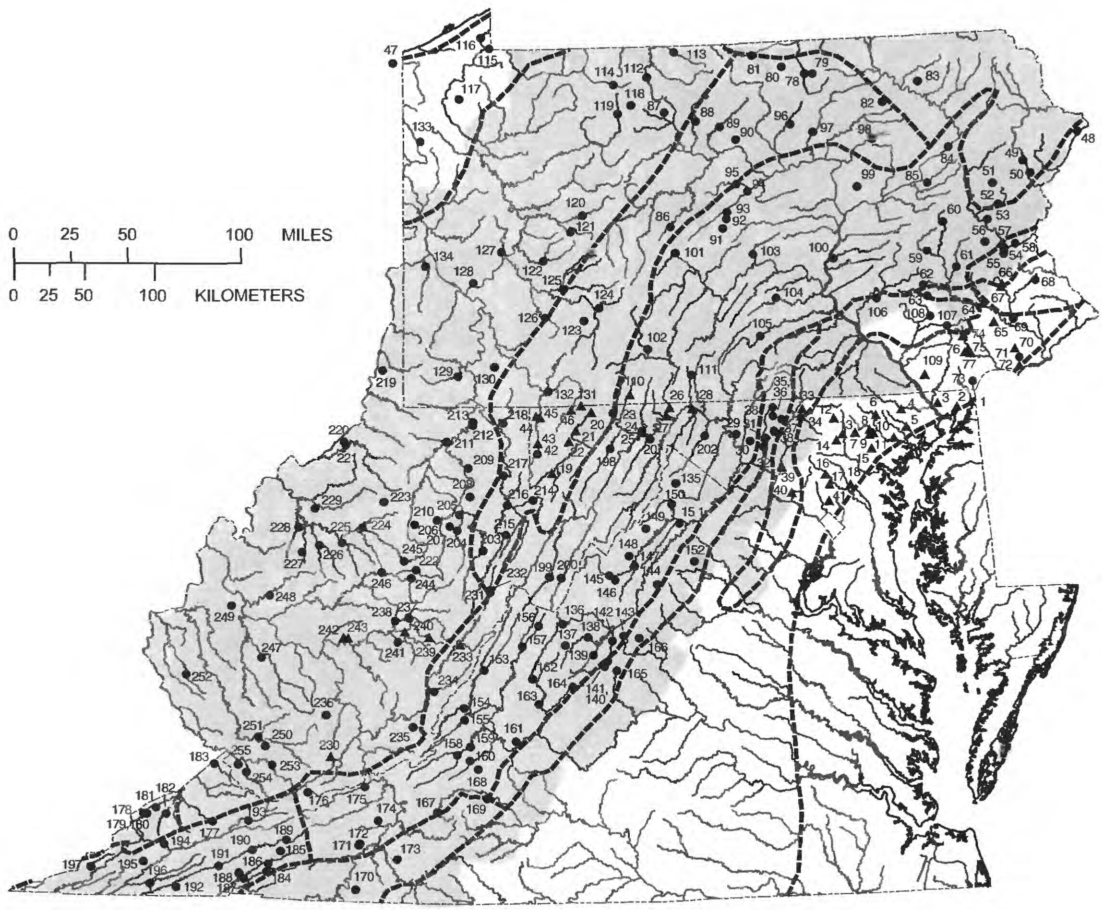
Table 1. Agencies and institutions contacted for Mid-Atlantic Highlands channel-geometry data as a result of the web search for all data prior to May 2003--Continued

Name of agency or institution
WEST VIRGINIA
Downstream Alliance
Laurel Run Watershed Association
West Virginia Department of Natural Resources
West Virginia Division of Forestry
West Virginia Soil Conservation Agency
West Virginia University
West Virginia University Natural Resource Analysis Center
West Virginia Water Research Institute
West Virginia Department of Commerce Labor and Environmental Resources
West Virginia Department of Environmental Protection
NATIONAL
National Academy of Science
National Resources Conservation Service
U. S. Department of Agriculture Forest Service
U. S. Department of Agriculture Fernow Experimental Forest
U. S. Department of Agriculture Forest Service Northeastern Research Station Timber and Watershed Lab
U. S. Department of Agriculture Natural Resources Conservation Service Watershed Science Institute
U. S. Environmental Protection Agency, Office of Water Quality
U. S. Fish & Wildlife Service
Water Quality Association

An assessment was made of USGS gaging stations in the Mid-Atlantic Highlands of Pennsylvania, Maryland, Virginia, and West Virginia. Those USGS gaging stations that have potential for use in regional curve studies in the Mid-Atlantic Highlands study area were tabulated (table 2). A geographic-information-system (GIS) data coverage was prepared showing gaging station locations where data is available, and locations meeting selection criteria for collection of additional data (fig. 2). The following criteria were used for this assessment:

- The site was located at a USGS gaging station.
- The site was on a stream with drainage located primarily in one physiographic province.
- The gaging station had 10 years or more of data for annual peak flows ending after 1985, or before 1985 if the basin has not experienced significant land-use changes.
- The site had a drainage area of less than 250 mi^2.
- The drainage basins had less than 20-percent urban land use.
- Less than 20 percent of the drainage area had regulated flow.
- The site had minimal effects from inter-basin flow (flow into or out of basins due to drainage ditches and strip benches related to mining or through solution channels in karst areas).

Only six gaging stations with less than one mi^2 drainage area are identified (table 3), and there are no gaging stations in the Piedmont physiographic province with less than one mi^2 drainage area (fig. 3). Gages with less than one mi^2 drainage are considered desirable for increasing the accuracy of regional curve development. Many of the gaging stations identified in the tables did not collect continuous streamflow record, especially those with drainage areas less than about 50 mi^2. Typically, these non-continuous gaging stations have stage-discharge relations determined by theoretical methods with few measured discharges. More continuous gages with drainage areas less than about 50 mi^2 could provide more accurate stage-discharge relations because more measured discharges would be required (fig. 3). Greater accuracy of stage-discharge relations could result in better determinations of bankfull discharge.



Map data sources: Physiographic Provinces and Sections: Fenneman (1938);
Mid-Atlantic Highlands boundary: Corey Anderson (Canaan Valley Institute, written commun., 2003);
Geomorphic data collection gaging station locations: Clear Creek Consulting (Canaan Valley Institute, written commun. 2003), Cinotto (2003), McCandless and Everett (2002, 2003), and White (2001).

EXPLANATION

USGS GAGING STATIONS

39 ▲ Geomorphic data collected

222 ● No geomorphic data collected to date

MID-ATLANTIC HIGHLANDS

MAJOR STREAMS

PHYSIOGRAPHIC PROVINCES AND SECTIONS

POLITICAL BOUNDARIES

State

Coastal

Figure 2. U.S. Geological Survey stream gaging stations in the Mid-Atlantic Highlands and adjacent areas, with potential for use in developing regional channel-geometry curves.

Table 2. U. S. Geological Survey stream gaging stations in the Mid-Atlantic Highlands and adjacent areas with potential for use in developing regional channel-geometry curves

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
		Appalachian Plateaus Physiographic Province	
49	1440300	Mill Creek at Mountainhome, PA	5.84
50	1440400	Brodhead Creek near Analomink, PA	65.9
51	1448500	Dilldown Creek near Long Pond, PA	2.39
52	1449360	Pohopoco Creek at Kresgeville, PA	49.9
78	1516350	Tioga River near Mansfield, PA	153.
79	1516500	Corey Creek near Mainesburg, PA	12.2
80	1518420	Crooked Creek below Catlin Hollow at Middlebury Center, PA	74.3
81	1518862	Cowanesque River at Westfield, PA	90.6
82	1532200	South Branch Towanda Creek at New Albany, PA	13.3
83	1533250	Tuscarora Creek near Silvara, PA	11.8
86	1542000	Moshannon Creek at Osceola Mills, PA	68.8
87	1542810	Waldy Run near Emporium, PA	5.24
88	1543700	First Fork Sinnemahoning Creek at Wharton, PA	182
89	1544500	Kettle Creek at Cross Fork, PA	136
90	1545600	Young Womans Creek near Renovo, PA	46.2
95	1547950	Beech Creek at Monument, PA	152
96	1549500	Blockhouse Creek near English, PA	37.7
97	1550000	Lycoming Creek near Trout Run, PA	173
98	1552500	Muncy Creek near Sonestown, PA	23.8
23	1601500	Wills Creek near Cumberland, MD	247
112	3009680	Potato Creek at Smethport, PA	160
113	3010655	Oswayo Creek at Shinglehouse, PA	98.7
114	3011800	Kinzua Creek near Guffey, PA.	46.4
115	3021350	French Creek near Wattsburg, PA.	92.0
116	3021410	West Branch French Creek near Lowville, PA	52.3
117	3022540	Woodcock Creek at Blooming Valley, PA	31.1
118	3026500	Sevenmile Run near Rasselas, PA	7.84
119	3027850	West Branch Clarion River at Wilcox, PA	63.0
120	3034000	Mahoning Creek at Punxsutawney, PA	158
121	3034500	Little Mahoning Creek at McCormick, PA	87.4
122	3038000	Crooked Creek at Idaho, PA	191
123	3039925	North Fork Bens Creek at North Fork Reservoir, PA	3.45
124	3041000	Little Conemaugh at East Conemaugh, PA	183
125	3042000	Blacklick Creek at Josephine, PA	192
126	3045000	Loyalhanna Creek at Kingston, PA	172
127	3049000	Buffalo Creek near Freeport, PA	137
128	3049800	Little Pine Creek near Etna, PA	5.78
203	3050000	Tygart Valley River near Dailey, WV	185
204	3051500	Middle Fork River at Midvale, WV	122
205	3052000	Middle Fork River at Audra, WV	148
206	3052340	Mud Lick Run near Buckhannon, WV	2.33
207	3052500	Sand Run near Buckhannon, WV	14.3
208	3055040	Bonica Run on Route 38 near Phillipi, WV	3.15

Table 2. U. S. Geological Survey stream gaging stations in the Mid-Atlantic Highlands and adjacent areas with potential for use in developing regional channel-geometry curves-- Continued

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
		Appalachian Plateaus Physiographic Province--Continued	
209	3056250	Three Fork Creek near Grafton, WV	96.8
210	3057500	Skin Creek near Brownsville, WV	25.7
211	3061500	Buffalo Creek at Barrackville, WV	116
212	3062400	Cobun Creek at Morgantown, WV	11.0
213	3062500	Deckers Creek at Morgantown, WV	63.2
214	3066000	Blackwater River at Davis, WV	85.9
215	3068610	Taylor Run at Bowden, WV	5.06
216	3069000	Shavers Fork at Parsons, WV	213
217	3069880	Buffalo Creek near Rowlesburg, WV	12.2
218	3070500	Big Sandy Creek near Rockville, WV	200
129	3073000	South Fork Tenmile Creek at Jefferson, PA	180
130	3074500	Redstone Creek at Waltersburg, PA	73.7
42	3075500	Youghiogheny River near Oakland, MD	134
132	3080000	Laurel Hill Creek at Ursina, PA	121
133	3102500	Little Shenango River at Green, PA	104
134	3108000	Racoon Creek at Miffatts Mill, PA	178
219	3113700	Little Grave Creek near Glendale, WV	4.95
220	3114550	Buffalo Run near Friendly, WV	0.88
221	3114650	Buffalo Run near Little, WV	4.19
222	3151400	Little Kanawha River near Wildcat, WV	112
223	3152200	Buck Run near Leopold, WV	2.91
224	3152500	Leading Creek near Glenville, WV	144
225	3153000	Steer Creek near Grantsville, WV	162
226	3154000	West Fork Little Kanawha River at Rocksdale, WV	205
227	3154250	Tanner Run at Spencer, WV	2.82
228	3154500	Reedy Creek near Reedy, WV	79.4
229	3155450	Big Island Run near Elizabeth, WV	3.52
231	3180350	West Fork Greenbrier River Tributary at Durbin, WV	1.13
232	3180500	Greenbrier River at Durbin, WV	133
235	3183000	Second Creek near Second Creek, WV	80.8
236	3185000	Piney Creek at Raleigh, WV	52.7
237	3186500	Williams River at Dyer, WV	128
238	3187000	Gauley River at Camden on Gauley, WV	236
241	3189000	Cherry River at Fenwick, WV	150
243	3191500	Peters Creek near Lockwood, WV	40.2
244	3195100	Right Fork Holly River at Guardian, WV	51.9
245	3195250	Left Fork Holly River near Replete, WV	46.5
246	3195600	Granny Creek at Sutton, WV	6.98
247	3198450	Drawdy Creek near Peytona, WV	7.75
248	3201000	Pocatalico River at Sissonville, WV	238
249	3201410	Poplar Fork at Teays, WV	8.47
250	3202480	Brier Creek at Fanerock, WV	7.34
251	3202750	Clear Fork at Clear Fork, WV	126
252	3206600	East Fork Twelvepole Creek near Dunlow, WV	38.5

Table 2. U. S. Geological Survey stream gaging stations in the Mid-Atlantic Highlands and adjacent areas with potential for use in developing regional channel-geometry curves-- Continued

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
		Appalachian Plateaus Physiographic Province--Continued	
178	3208700	North Fork Pound River at Pound, VA	18.5
179	3208800	Pound River above Indian Creek at Pound, VA	36.7
180	3208850	Pound River below Bold Camp Creek at Pound, VA	61.2
181	3208900	Pound River near Georges Fork, VA	82.5
182	3208950	Cranes Nest River near Clintwood, VA	66.5
253	3212750	Tug Fork at Welch, WV	174
254	3212980	Dry Fork at Beartown, WV	209
255	3213500	Panther Creek near Panther, WV	31.0
183	3213590	Knox Creek at Kelsa, VA	84.3
47	4213000	Conneaut Creek at Conneaut, OH	175
		Blue Ridge Physiographic Province	
140	1626000	South River near Waynesboro, PA	127
141	1626850	South River near Dooms, VA	149
31	1637000	Little Catoctin Creek at Harmony, MD	8.83
32	1637500	Catoctin Creek near Middletown, MD	66.9
35	1640500	Owens Creek at Lantz, MD	5.93
36	1640965	Hunting Creek near Foxville, MD	2.14
37	1641000	Hunting Creek at Jimtown, MD	18.4
38	1641500	Fishing Creek near Lewistown, MD	7.29
152	1662500	Rush River at Washington, VA	14.7
165	2030800	Stockton Creek near Afton, VA	2.80
166	2032300	Muddy Run near Standardsville, VA	3.36
169	2056650	Back Creek near Dundee, VA	56.8
170	3165000	Chestnut Creek at Galax, VA	39.4
173	3167300	Mira Fork Tributary near Dugspur, VA	0.62
		Piedmont Physiographic Province	
63	1470853	Furnace Creek at Robesonia, PA	4.18
68	1472620	East Branch Perkiomen Creek near Dublin, PA	4.05
69	1473120	Skippack Creek Near Collegeville, PA	53.7
71	1476480	Ridley Creek at Media, PA	30.5
73	1478200	Middle Branch White Clay Creek near Landenberg, PA	12.7
106	1573160	Quittapahilla Creek near Belle, PA	74.2
107	1576085	Little ConestogaCreek near Churchtown, PA	5.82
108	1576320	Stony Run at Reamstown, PA	3.55
		Valley and Ridge Physiographic Province	
48	1438300	Vandermark Creek at Milford, PA	5.36
53	1450500	Aquashicola Creek at Palmerton, PA	76.7

Table 2. U. S. Geological Survey stream gaging stations in the Mid-Atlantic Highlands and adjacent areas with potential for use in developing regional channel-geometry curves-- Continued

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
		Valley and Ridge Physiographic Province--Continued	
54	1451500	Little Lehigh Creek near Allentown, PA	80.8
55	1451650	Little Lehigh Creek at 10th Street Bridge at Allentown, PA	98.2
56	1451800	Jordan Creek near Schnecksville, PA	53.0
57	1452000	Jordan Creek at Allentown, PA.	75.8
58	1452500	Monocacy Creek at Bethlehem, PA	44.5
59	1468500	Schuylkill River at Landingville, PA	133
60	1469500	Little Schuylkill River,Tamaqua, PA	42.9
61	1470756	Maiden Creek at Virginville, PA	159
62	1470779	Tulpehocken Creek near Bernville, PA	66.5
84	1537000	Toby Creek at Luzerne, PA.	32.4
85	1538000	Wapawallopen Creek near Wapwallopen, PA	43.8
91	1546400	Spring Creek at Houserville, PA	58.5
92	1546500	Spring Creek near Axemann, PA	87.2
93	1547100	Spring Creek at Milesburg, PA	142
94	1547700	Marsh Creek at Blanchard, PA	44.1
99	1553700	Chillisquaque Creek at Washingtonville, PA	51.3
100	1555500	East Mahantango Creek near Dalmatia, PA	162
101	1557500	Bald Eagle Creek at Tyrone, PA	44.1
102	1560000	Dunning Creek at Belden, PA	172
103	1565000	Kishacoquillas Creek at Reedsville, PA	164
104	1567500	Bixler Run near Loysville, PA	15.0
105	1569340	Newburg Run at Newburg, PA	5.29
198	1604500	Patterson Creek near Headsville, WV	211
199	1605500	South Branch Potomac River at Franklin, WV	179
200	1607500	South Fork South Branch Potomac River at Brandywine, WV	103
24	1609000	Town Creek near Oldtown, MD	148
201	1609800	Little Cacapon River near Levels, WV	108
111	1613050	Tonoloway Creek near Needmore, PA	10.7
135	1613900	Hogue Creek near Hayfield, VA	15.0
202	1614000	Back Creek near Jones Springs, WV	235
29	1617800	Marsh Run at Grimes, MD	18.9
30	1619475	Dog Creek Tributary near Locust Grove, MD	0.10
136	1620500	North River near Stokesville, VA	17.2
137	1622400	Buffalo Branch Tributary Number 2 near Christians, VA	0.49
138	1624300	Middle River near Verona, VA	178
139	1624800	Christians Creek near Fishersville, VA	70.1
142	1627500	South River at Harriston, VA	212
143	1628060	White Oak Run near Grottoes, VA	1.94
144	1629945	Chub Run near Stanley, VA	3.16
145	1632000	North Fork Shenandoah at Cootes Store, VA	210
146	1632082	Linville Creek at Broadway, VA	45.5
147	1632900	Smith Creek near New Market, VA	93.2
148	1632970	Crooked Run near Mount Jackson, VA	6.49
149	1633650	Pugh's Run near Woodstock, VA	3.66

Table 2. U. S. Geological Survey stream gaging stations in the Mid-Atlantic Highlands and adjacent areas with potential for use in developing regional channel-geometry curves-- Continued

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
		Valley and Ridge Physiographic Province--Continued	
150	1634500	Cedar Creek near Winchester, VA	103
151	1635500	Passage Creek near Buckton, VA	87.8
153	2011400	Jackson River near Bacova, VA	158
154	2013000	Dunlap Creek near Covington, VA	164
155	2014000	Potts Creek near Covington, VA	153
156	2015600	Cowpasture River near Head Waters, VA	11.3
157	2015700	Bullpasture River at Williamsville, VA	110
158	2017500	Johns Creek at New Castle, VA	104
159	2017700	Craig Creek Tribuatry near New Castle, VA	2.05
160	2018500	Catawba Creek near Catawba, VA	34.3
161	2020100	Renick Run near Buchanan, VA	2.06
162	2020500	Calfpasture River above Mill Creek at Goshen, VA	144
163	2022500	Kerrs Creek near Lexington, VA	35.0
164	2023300	South River near Steeles Tavern, VA	15.7
167	2053800	South Fork Roanoke River near Shawsville, VA	110
168	2055100	Tinker Creek near Daleville, VA	11.7
171	3166800	Glade Creek at Grahams Forge, VA	7.15
172	3167000	Reed Creek at Grahams Forge, VA	247
174	3168750	Thorne Springs Branch near Dublin, VA	4.77
175	3175500	Wolf Creek near Narrows, VA	223
176	3177710	Bluestone River at Falls Mills, VA	44.2
177	3208040	Russell Fork at Council, VA	10.2
184	3471500	South Fork Holston River at Riverside near Chilhowie, VA	76.1
185	3473500	Middle Fork Holston River at Groseclose, VA	7.39
186	3474000	Middle Fork Holston River at Seven Mile Ford, VA	132
187	3475000	Middle Fork Holston River near Verona, VA	211
188	3475600	Cedar Creek near Meadowview, VA	3.38
189	3487800	Lick Creek near Chatham Hill, VA	25.5
190	3488000	North Fork Holston River near Saltville, VA	222
191	3488450	Brumley Creek at Brumley Gap, VA	21.1
192	3489800	Cove Creek near Shelleys, VA	17.3
193	3521500	Clinch River at Richlands, VA	137
194	3524500	Guest River at Coeburn, VA	87.3
195	3524900	Stoney Creek at Ka, VA	30.9
196	3526000	Copper Creek near Gate City, VA	106
197	3530500	North Fork Powell River at Pennington Gap, VA	71.4

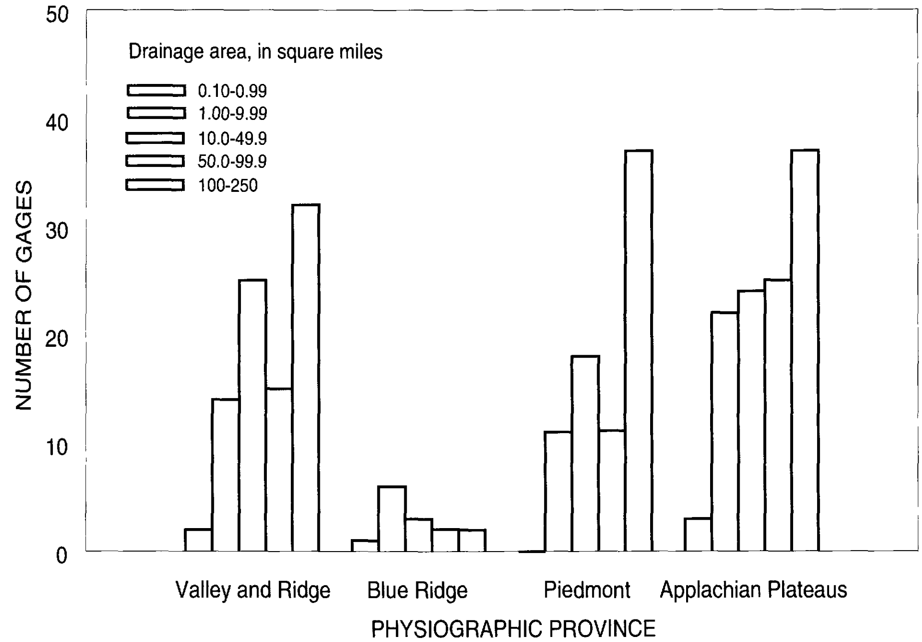


Figure 3. Drainage-area size distribution of U.S. Geological Survey stream gaging stations within the indicated Physiographic Province in the Mid-Atlantic Highlands.

Table 3. U.S. Geological Survey stream gaging stations within the Mid-Atlantic Highlands identified as having drainage areas of less than one square mile

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
30	1619475	Dog Creek Tributary near Locust Grove, MD	0.10
137	1622400	Buffalo Branch Tributary Number 2 near Christians, VA	0.49
43	3075600	Toliver Run Tributary near Hoyes Run, MD	0.53
44	3076505	Youghiogheny river Tributary near Friendsville, MD	0.22
220	3114550	Buffalo Run near Friendly, WV	0.88
173	3167300	Mira Fork Tributary near Dugspur, VA	0.62

ASSESSMENT OF CHANNEL GEOMETRY DATA THROUGH MAY 2003

At the beginning of this study it was recognized that only limited channel-geometry information had been published for the Mid-Atlantic Highlands of Pennsylvania, Maryland, Virginia, and West Virginia. After data inquiries to 78 entities (table 1), only four published reports were located. These reports are:

- Cinotto, P.J., 2003, Development of regional curves of bankfull-channel geometry and discharge for streams in the non-urban Piedmont Physiographic Province, Pennsylvania and Maryland: U.S. Geological Survey Water-Resources Investigations Report 03-4014, 27 p.

- McCandless, T.L. and Everett, R.A, 2002, Maryland stream survey: Bankfull discharge and channel characteristics in the Piedmont hydrologic region: U.S. Fish and Wildlife Service, Annapolis, MD. CBFO-S02-01, 41 pp.

- McCandless, T.L. and Everett, R. A., 2003, Maryland stream survey: Bankfull discharge and channel characteristics of streams in the Allegheny Plateau and the Valley and Ridge hydrologic regions: U.S. Fish and Wildlife Service, Annapolis, MD., CBFO-S03-01.

- White, K.E., 2001, Regional curve development and selection of a reference reach in the non-urban, lowland sections of the Piedmont Physiographic Province, Pennsylvania and Maryland: U.S. Geological Survey Water-Resources Investigations Report 01-4146, 20 p.

An additional set of unpublished data (Upper Knapp Creek Watershed Assessment), collected in the study area was submitted by Canaan Valley Institute (written commun. 2003) and reviewed. Data for all but one site in this study met the assessment selection criteria. The data not meeting the selection criteria were eliminated because less than 10 years of annual-peak flow record were available.

Regional curves were developed by Dunn and Leopold (1978), applicable to different regions of the United States. Data used for development of those curves were not assessed as part of this study because the publication date was before the 1985 date used as an assessment criterion to limit the effects of landuse changes. Regional curves have been developed by the North Carolina Stream Restoration Institute for areas adjacent to the study area (http://www.ncsu.edu/sri/regional.htm). These curves were not assessed as part of this study because the information is not within the study area and has not been peer reviewed or published.

Pennsylvania Stream Surveys

The Pennsylvania District of the USGS conducted two studies in the Piedmont Physiographic Province in Pennsylvania and part of Maryland. Data was collected and relations between drainage area and stream discharge and channel-geometry dimensions were developed. The first study collected information in only the Lowland Sections of the Piedmont Physiographic Province (table 4). The results of the first study were published by White (2001) in the USGS report, "Regional Curve Development and Selection of a Reference Reach in the Non-Urban, Lowland Sections of the Piedmont Physiographic Province, Pennsylvania and Maryland." The second study collected additional data in the Uplands Sections of the Piedmont Physiographic Province (table 5). The results of the second study were published by Cinotto (2003) in the USGS report, "Development of Regional Curves of Bankfull-Channel Geometry and Discharge for Streams in the Non-Urban Piedmont Physiographic Province, Pennsylvania and Maryland." The curves from the second study supercede those developed in the first study.

Identical field methods, (Leopold, 1994 and Rosgen, 1996) were used to collect data for both studies. The reports identify deviations from these protocols specific to particular gages. Quality assurance was provided by collecting information at gaging stations. Streamflow measurement data, relations between stage and discharge, annual-peak frequency analyses, and stream profiles of bankfull, water surface, and streambed were used to assure that field indicators for bankfull stage were accurately identified. A calculation of bankfull discharge, using channel roughness determined from a pebble count for application of open-channel flow equation, was compared to the relations between stage and discharge at the gaging station to assure that bankfull was properly identified.The first Pennsylvania study used a criterion of no greater than 20-percent urban land use and the second study used a criterion of no greater than 25 percent.

Table 4. U. S. Geological Survey stream gaging stations in the Lowlands Section of the Piedmont Physiographic Province in Pennsylvania and Maryland where channel-geometry data was collected by White (2001)

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
64	1471980	Manatawny Creek near Pottstown, PA	85.5
65	1472157	French Creek near Phoenixville, PA	59.1
66	1472198	Perkiomen Creek at East Greenville, PA	38.0
67	1472199	West Branch Perkiomen Creek at Hillegas, PA	23.0
76	1480610	Sucker Run near Coatesville, PA	2.57
34	1639500	Big Pipe Creek at Bruceville, MD	102

Table 5. U. S. Geological Survey stream gaging stations in the Piedmont Physiographic Province in Pennsylvania and Maryland where channel-geometry data was collected by Cinotto (2003)

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
70	1475850	Crum Creek near Newtown Square, PA	15.8
72	1477000	Chester Creek near Chester, PA	61.1
74	1480300	West Branch Brandywine Creek near Honey Brook, PA	18.7
75	1480500	West Branch Brandywine Creek at Coatesville, PA	45.8
77	1480617	West Branch Brandywine Creek at Modena, PA	55.0
109	1578200	Conowingo Creek near Buck, PA	8.7
13	1586210	Beaver Run near Finksburg, MD	14.0
14	1586610	Morgan Run at Louisville, MD	28.0

Only one site, Chester Creek near Chester (01477000), exceeds the less than 20-percent urban landuse assessment criterion; this station had 23-percent urban land use. It is included in the streamflow network for possible use in developing regional curves for the Mid-Atlantic Highlands (fig. 2, table 5) because it is located within the study area and the information has been reviewed and published. However, data for this station should only be used for developing regional curves if the filtering criterion for urbanization is changed from the less than 20-percent urban land use assessment criterion to a criterion of less than 25 percent.

Maryland Stream Surveys

The Chesapeake Bay Field Office of the U. S. Fish and Wildlife Service (USFWS) surveyed streams at selected USGS gaging stations in three physiographic provinces in Maryland to develop quantitative regional relations between drainage area, and stream discharge and channel-geometry dimensions. The results provide basic information to reduce impacts to streams from road crossings, develop improved stream channel restoration designs, and evaluate stream channel conditions. The first physiographic province surveyed was the Piedmont (table 6). The results were published by McCandless and Everett (2002) in the U.S. Fish and Wildlife Service report, "Bankfull Discharge and Channel Characteristics of Streams in the Piedmont Hydrologic Region." The second and third physiographic provinces surveyed were the Appalachian Plateaus (identified as the Allegheny Plateaus which refers to the Allegheny Mountain sub-section of the Appalachian Plateaus) and the Valley and Ridge (table 7). The results of these surveys were published by McCandless and Everett (2003) in the U.S. Fish and Wildlife Service report, "Bankfull Discharge and Channel Characteristics of Streams in the Allegheny Plateau and Valley and Ridge Hydrologic Regions."

Table 6. U.S. Geological Survey stream gaging stations in the Piedmont Physiographic Province in Pennsylvania and Maryland where channel-geometry data was collected by McCandless and Everett (2002)

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
1	1495000	Big Elk Creek at Elk Mills, MD	52.6
2	1496000	Northeast Creek at Leslie, MD	24.3
3	1579000	Basin Run at Liberty Grove, MD	5.31
4	1580000	Deer Creek at Rocks, MD	94.4
5	1581700	Winters Run near Benson, MD	34.8
6	1582000	Little Falls at Blue Mount, MD	52.9
7	1583000	Slade Run near Glyndon, MD	2.09
8	1583500	Western Run at Western Run, MD	59.8
9	1583580	Baisman Run at Broadmoore, MD	1.47
10	1583600	Beaverdam Run at Cockeysville, MD	20.9
11	1584050	Long Green Creek at Glen Arm, MD	9.4
12	1585500	Cranberry Branch near Westminster, MD	3.4
13	1586210	Beaver Run near Finksburg, MD	14
14	1586610	Morgan Run at Louisville, MD	28
15	1589440	Jones Falls at Sorrento, MD	25.2
16	1591000	Patuxent River near Unity, MD	34.8
17	1591700	Hawlings River near Sandy Spring, MD	27
18	1593500	Little Patuxent River at Guilford, MD	38
33	1639140	Piney Creek at Taneytown, MD	31.3
34	1639500	Big Pipe Creek at Bruceville, MD	102
39	1643500	Bennett Creek at Park Mills, MD	62.8
40	1645000	Seneca Creek at Dawsonville, MD	101
41	1650500	North West Branch Anacostia River near Colesville, MD	21.1

McCandless and Everett (2002, and 2003) developed field protocols, survey methods, and gage selection criteria for both studies on the basis of Annable (1994), Harrelson and others (1994), Leopold (1994), and Rosgen (1996). Gage selection criteria included stations with at least 10 years of data for annual peak flows. Some station records for peak flows ended before 1985, but ratings were confirmed at these sites by making streamflow measurements. Drainage areas were less than 250 mi^2, although this was not identified as a selection criterion. Drainage basins were identified as unregulated, which met the less than 20-percent criterion, and there were minimal effects from inter-basin flow.

Data published by McCandless and Everett (2002) in the report, "Bankfull Discharge and Channel Characteristics of Streams in the Piedmont Hydrologic Region," were collected from 23 USGS gaging stations in the Piedmont Physiographic Province of Maryland (fig. 2, table 6).

Table 7. U. S. Geological Survey stream gaging stations in the Appalachian Plateaus and Valley and Ridge Physiographic Provinces of Pennsylvania and Maryland where channel-geometry data was collected by McCandless and Everett (2003)

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
		Appalachian Plateaus Physiographic Province	
19	1595000	North Branch Potomac River at Steyer, MD	73.1
20	1596005	Savage River near Frostburg, MD	1.50
21	1596500	Savage River near Barton, MD	49.1
22	1597000	Crabtree Creek near Swanton, MD	16.7
43	3075600	Toliver Run Tributary near Hoyes Run, MD	0.53
44	3076505	Youghiogheny River Tributary near Friendsville,MD	0.22
45	3076600	Bear Creek at Friendsville, MD	48.9
46	3078000	Casselman River at Grantsville, MD	62.5
131	3078500	Big Piney Run near Salisbury, PA	62.5
		Valley and Ridge Physiographic Province	
110	1603500	Evitts Creek near Centerville, PA	30.2
25	1609500	Sawpit Run near Oldtown, MD	5.08
26	1610150	Bear Creek at Forest Park, MD	10.4
27	1610155	Sideling Hill Creek near Bellegrove, MD	102
28	1613150	Ditch Run near Hancock, MD	4.80

Data published by McCandless and Everett (2003) in the report, "Bankfull Discharge and Channel Characteristics of Streams in the Allegheny Plateau and Valley and Ridge Hydrologic Regions," were collected from 14 USGS gaging stations in the Appalachian Plateaus and the Valley and Ridge Physiographic Provinces (fig. 2, table 7).

Among the 23 stations analyzed by McCandless and Everett (2002), eight did not meet the 20-percent urban land use criterion: Beaver Run near Finksburg (01586210) with 23 percent, Beaverdam Run at Cockeysville (01583600) with 40 percent, Jones Falls at Sorrento (01589440) with 54 percent, Little Patuxent River at Guilford (01593500) with 41 percent, Long Green Creek at Glen Arm (01584050) with 28 percent, Northwest Branch Anacostia River near Colesville (01650500) with 43 percent, Seneca Creek at Dawsonville (01645000) with 25 percent, and Winters Run near Benson (01581700) with 23 percent. All of these stations are located in the Piedmont Physiographic Province, outside the Mid-Atlantic Highlands. These stations have been retained in this report because the information has been reviewed and published, but data for these stations should be used for developing regional curves only if the overall filtering criterion for urbanization is changed.

Table 8. U. S. Geological Survey stream gaging stations in the Appalachian Plateaus and Valley and Ridge Physiographic Provinces of West Virginia where channel-geometry data was collected by Rocky Powell of Clear Creeks Consulting

Map number (fig. 2)	Station number	Station name	Drainage area, in square miles
		Appalachian Plateaus Physiographic Province	
230	3178500	Camp Creek near Camp Creek, WV	32.0
239	3187300	North Fork Cranberry River near Hillsboro, WV	9.78
240	3187500	Cranberry River near Richwood, WV	80.4
242	3191400	Laurel Creek near Summersville, WV	4.28
243	3191500	Peters Creek near Lockwood, WV	40.2
		Valley and Ridge Physiographic Province	
233	3182000	Knapp Creek at Marlinton, WV	108

USGS gaging stations were used as sampling sites to provide QA/QC for determining bankfull discharge. Streamflow measurements, relationships between stage and discharge, annual-peak frequency analyses, and stream profiles of bankfull, water surface, and streambed elevations were used to assure that field indicators for bankfull stage were identified accurately.

Upper Knapp Creek Watershed, West Virginia

Geomorphology data were collected by Rocky Powell of Clear Creek Consulting at seven sites in the Upper Knapp Creek watershed in West Virginia (Canaan Valley Institute, written commun., 2003). Six of these sites are identified in this report (fig. 2, table 8). One site was eliminated because it did it had less than 10 years of annual-peak flow record. Quality assurance for determining bankfull was provided by collecting information at USGS gaging stations. Streamflow measurement data, relations between stage and discharge, annual-peak frequency analyses, and stream profiles of bankfull, water surface, and streambed elevation were used to assure that field indicators for bankfull stage were identified accurately.

SUMMARY

Stream channels often need to be reconstructed because of disturbance by human activities or natural events. Channels are more stable when designed in accordance with the natural tendencies of rivers. These designs require basic information on stream characteristics, bankfull discharge, and channel-geometry or stream-morphology characteristics.

The assessment of available geomorphology studies through May 2003 revealed the need for additional geomorphology data in the Mid-Atlantic Highlands of Pennsylvania, Maryland, Virginia, and West Virginia. There is very little documentation of bankfull discharge and channel-geometry characteristics of streams in the physiographic regions within the study area.

Four published reports and one unpublished study were located and assessed against criteria that included a minimum of 10 years of annual-peak flows ending after 1985, or ending before 1985 if the basin has not experienced significant land-use changes, drainage areas of less than 250 mi^2, drainage basins with less than 20-percent urban land use, drainage basins with flow regulated from less than 20 percent of the drainage area, and with minimal effects from inter-basin flow. Among the information available, one station did not meet the 10 years of annual-peak flow criterion and nine stations did not meet the less than 20-percent urbanization criterion.

A list of stream gaging stations in the Mid-Atlantic Highlands that meet the selection criteria was prepared, and those with available channel-geometry data are identified. There is a dearth of continuous gages with drainage areas less than 50 square miles, and only six gages with a drainage area less than one square mile. This poses a problem since many of the restoration projects are on small streams. Therefore, additional continuous gaging stations with drainage areas less than 50 mi^2 could result in better estimates of bankfull, and additional gages with drainage areas less than one mi^2 could improve the accuracy of regional curves.

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