Methods for Estimating Streamflow and Analyzing Streamflow and Water-Quality Trends for the Surface-Water Ambient Monitoring Program (SWAMP) Network in Florida

U.S. GEOLOGICAL SURVEY

Open-File Report 97-352

Prepared in cooperation with the
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

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By Anne F. Choquette, Lisa K. Ham, and Agustín A. Sepúlveda

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CONVERSION FACTORS AND ACRONYMS

Multiply	By	To obtain
mile (mi)	1.609	kilometer
square mile (mi^2)	2.59	square kilometer
square mile (mi^2)	259.0	hectare
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Acronyms

ESTREND = EStimate TREND software
FDEP = Florida Department of Environmental Protection
LOWESS = LOcally WEighted Scatterplot Smoothing
NAWQA = National Water-Quality Assessment Program
OLS = Ordinary least squares
SWAMP = Surface-Water Ambient Monitoring Program
USGS = U.S. Geological Survey
MLE = Maximum likelihood estimation

Methods for Estimating Streamflow and Analyzing Streamflow and Water-Quality Trends for the Surface-Water Ambient Monitoring Program (SWAMP) Network in Florida

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Abstract

This report, completed in cooperation with the Florida Department of Environmental Protection, identifies the U.S. Geological Survey long-term streamflow stations in Florida and summarizes selected methods used within the U.S. Geological Survey to estimate streamflow and analyze trends in streamflow and water quality. The Florida Department of Environmental Protection will use this information to develop protocols for data collection and trend analyses in their Surface-Water Ambient Monitoring Program (SWAMP) network. Because water quality usually varies with streamflow, analysis of trends in water quality must also address streamflow and its effects on water quality. Streamflow measurement is not currently a part of water-quality sampling at the SWAMP network trend sites.

The U.S. Geological Survey streamflow stations at or near SWAMP network trend sites as of 1996 are identified, and methods are presented for using these data to estimate instantaneous or daily mean streamflow coinciding with water-quality sampling at the SWAMP network trend sites. The streamflow-estimation methods include a flow-routing method based on drainage area and partial-record methods based on stage-discharge (streamflow) ratings and correlation between streamflow records.

Recommended methods for analyzing monotonic and step trends in streamflow, water quality, and flow-adjusted water-quality data include the nonparametric Kendall and rank-sum tests and the parametric procedure Tobit regression. The trend methods can perform seasonal analysis to aid in identifying existing trends, can accommodate data censored at multiple levels, and are well suited to multistation analysis. Data requirements, method selection, and restrictions on application are discussed in detail for the streamflow-estimation and trend methods.

INTRODUCTION

Surface-water-quality data are collected at 4,500 sites in Florida by 40 Federal, State, and local agencies. From these sites, the Florida Department of Environmental Protection (FDEP) has established a statewide Surface-Water Ambient Monitoring Program (SWAMP) network to assess water quality. The goal of the SWAMP network is to provide information on water quality in Florida in a technically sound, cost-efficient manner. Objectives of this network are to determine whether the water quality is changing over time and to identify water bodies with degrading water quality.

The first phase of the FDEP SWAMP is to establish a permanent water-quality trend network and to develop analytical techniques to detect trends in water quality over time. Subsequent phases will include implementing analytical protocols and evaluating data from the network. This report provides information to be used by the FDEP and contracting agencies in assessing water-quality and streamflow trends at these SWAMP sites and to aid in developing data-collection protocols so that reliable trend results can be obtained at monitoring sites. The current SWAMP trend network consists of 315 sampling sites on streams, lakes, and estuaries throughout Florida (fig. 1; plate 1). Subsequent references to SWAMP sites in this report denote SWAMP network trend sites.

Determining streamflow and evaluating its influence on water-quality conditions are critical components of the SWAMP network assessment. However, water-quality sampling at the SWAMP sites typically does not include measurement of streamflow. Only 71 (26 percent) of the 278 SWAMP network trend stations located on streams (excluding lakes and estuaries) have active or planned U.S. Geological Survey (USGS) streamflow-gaging stations onsite as of 1996. Variations in water quality are often closely related to variations in streamflow, and examination of the feasibility of estimating streamflow at ungaged SWAMP sites is important. Without streamflow data, trends in streamflow cannot be eliminated as causes for observed trends in water quality. Also, the relation between water quality and streamflow can be used to increase the probability of detecting existing water-quality trends, without increasing sampling frequency.

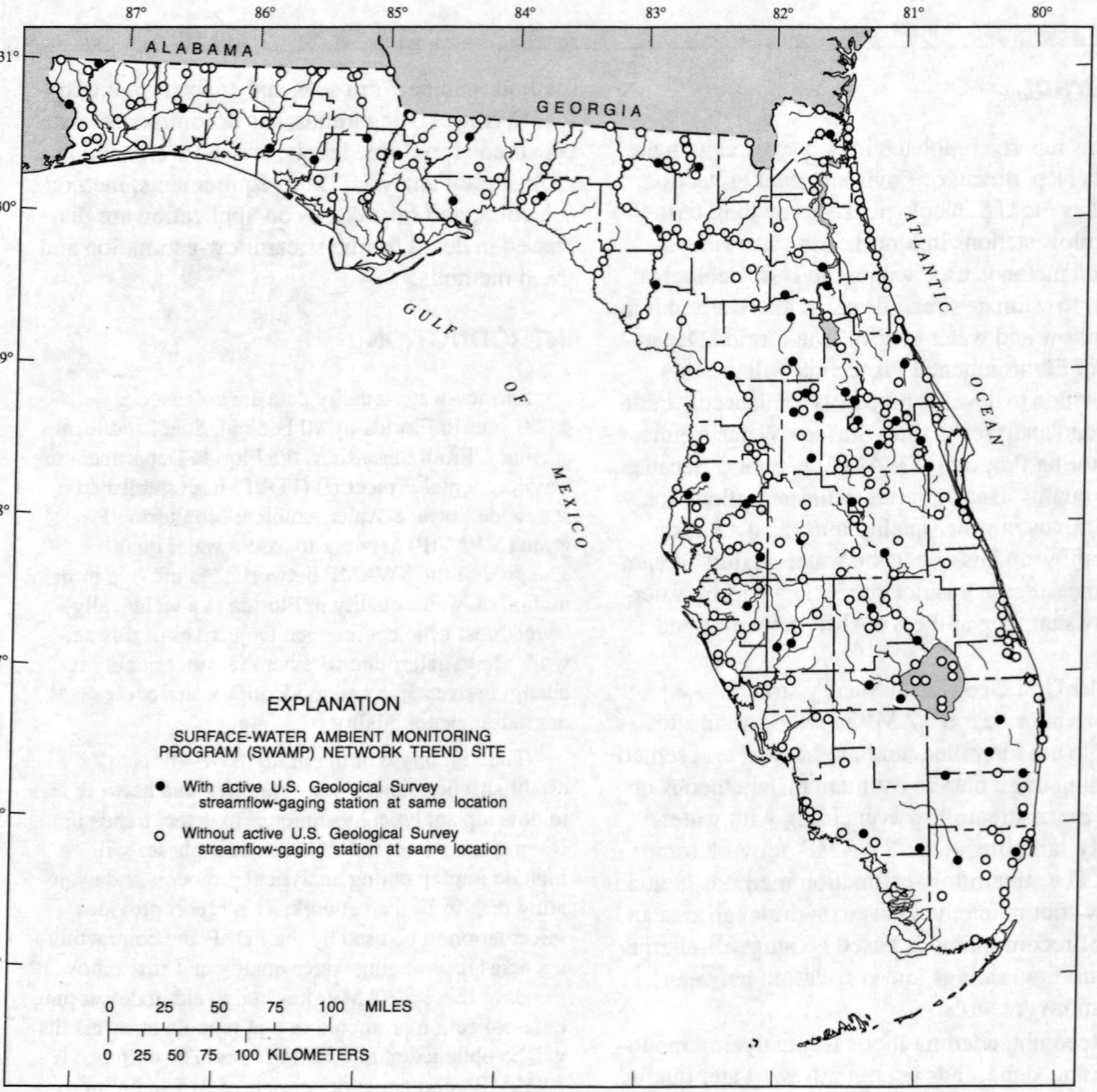


Figure 1. Locations of SWAMP (Surface-Water Ambient Monitoring Program) network trend sites and coincident locations of active U.S. Geological Survey streamflow-gaging stations.

PURPOSE AND SCOPE

The purpose of this report is to provide information to aid FDEP in assembling a streamflow data base for the SWAMP network and in developing protocols to accomplish the trend analysis of the SWAMP. Specifically, the report focuses on three tasks: (1) identifies USGS continuous-record long-term gaging stations as of 1996 for the purpose of determining streamflow at SWAMP sites; (2) provides methods for estimating streamflow at SWAMP sites without continuous-record gaging stations, including ungaged sites and sites having partial records; and (3) outlines methods, applicable to the SWAMP network, for analyzing trends in streamflow, water quality, and flow-adjusted water quality. The terms streamflow and flow in this report, refer to water flow in natural channels and in constructed waterways such as canals.

Streamflow-estimation methods were limited to the estimation of instantaneous flow or mean daily flow concurrent with the collection of water-quality samples. These methods utilize streamflow data from nearby continuous-record gaging stations having concurrent records with the SWAMP sites. They also utilize periodic measurements of streamflow and/or water level at SWAMP sites. USGS stations having only partial (intermittent) records of streamflow measurements (usually limited to high- or low-flow values) and lake-gaging stations are not included in this report. Rainfall-runoff models for estimating streamflow are not included in this report due to their site-specific applicability and intensive data requirements.

The trend methods in this report were selected on the basis of their suitability for large, multistation water-quality networks where multiple water-quality constituents are monitored at varying intervals. Selection is based on the experience of USGS personnel in trend analysis over the past 20 years. Although other trend methods exist, it is difficult to successfully apply most of these alternative methods to a multistation, multiconstituent data set for regional analyses. Many trend studies conducted by the USGS have focused on regional or statewide water-quality networks similar to the SWAMP network.

The trend methods discussed in this report have the properties of: (1) resistance to disproportionate effects of outliers (extremely unusual values), which are common in water-quality data; (2) ability to maximize the detection of existing trends by accounting for fluctuations in the water-quality record due to season (time of year) and streamflow; (3) ability to accommodate missing data and nonuniform sampling over time; and (4) ability to handle censored (less than a detection limit) water-quality data and multiple detection limits in a site record. The methods are particularly well suited to multistation studies, for reasons outlined in the section "Methods for Analyzing Trends."

Methodology guidelines, such as the minimum number of observations and the distribution of samples over time, are provided in this report for data requirements and application of the methods. References and selected examples are included in the report to provide more specific information for applying the methods.

IMPORTANCE OF STREAMFLOW DATA FOR WATER-QUALITY MONITORING

Streamflow data can provide important information for interpreting and evaluating water quality. Often, much of the observed variation in water quality is due to natural fluctuations in streamflow. A comparison of constituent concentrations to streamflow can provide information concerning the physical processes, such as dilution or wash-off, which affect the transport of constituents in the basin. Accounting for the effects of streamflow on water quality can significantly improve the ability of statistical tests to identify existing trends (Hirsch and others, 1991). When evaluating trends in water quality, concurrent trends in streamflow should be assessed as one of the potential causes. Loadings, or mass transport (the product of concentration and streamflow over a given time), cannot be determined without streamflow data. Knowledge of the range and duration of flows at a site can be used: (1) to evaluate the adequacy of historical water-quality sampling in representing specific flow conditions; (2) to evaluate the expected frequency of specific water-quality concentrations; and (3) to develop sampling protocols to ensure that target flows are sampled.

Increases in streamflow, for example during a storm event, can result in dilution, wash-off, or some combination of dilution and wash-off for different water-quality constituents. Dilution occurs when a solute is delivered to a stream at a relatively constant rate (due to a point source or ground-water discharge to the stream) and streamflow increases. This results in decreasing concentrations of the water-quality constituent with increasing flow (fig. 2A). Wash-off occurs

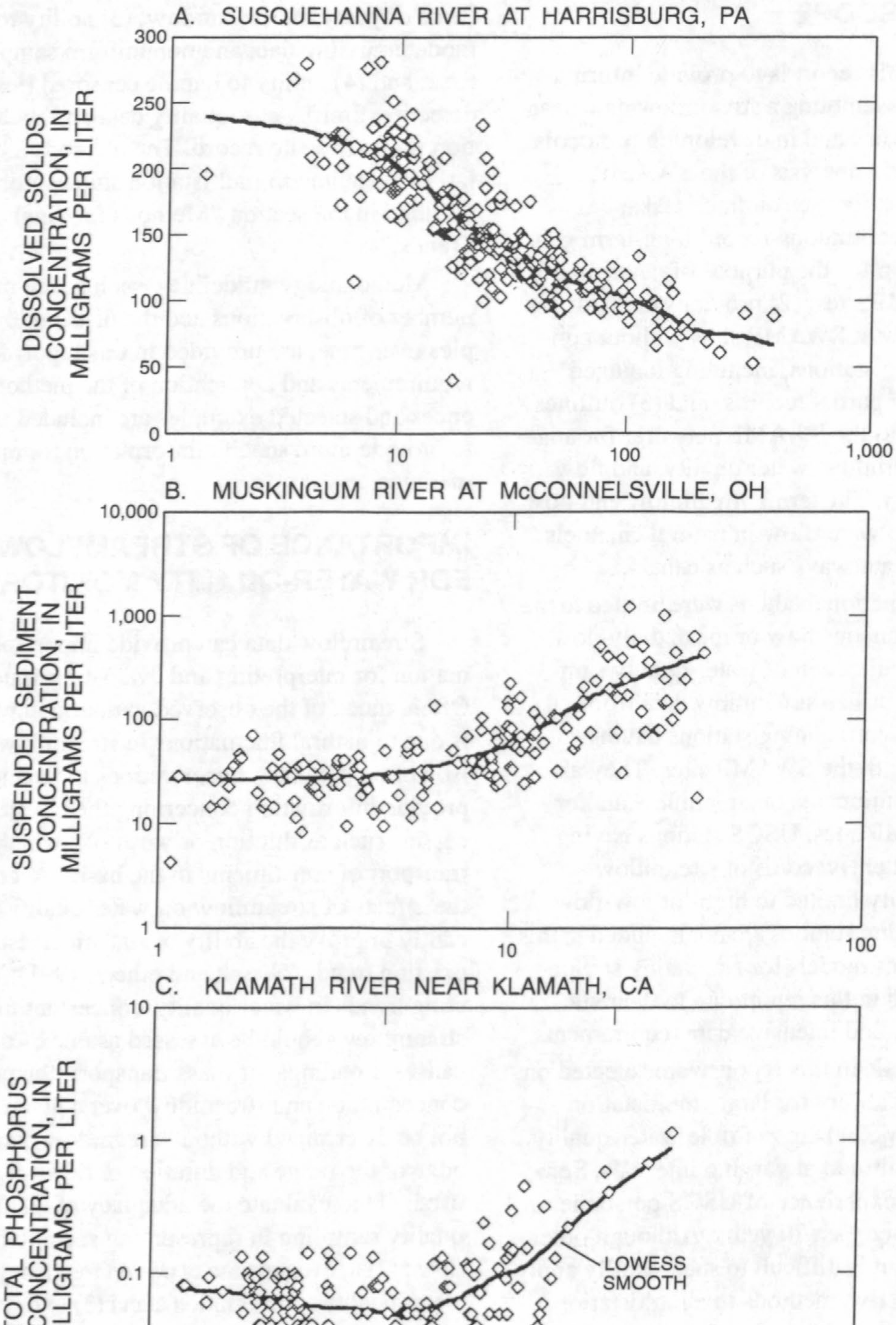


Figure 2. Examples of relations between water-quality constituent concentrations and stream discharge: (A) Concentrations of major ions released to the stream at a relatively constant rate, diluted by increases in stream discharge; (B) concentrations of suspended sediment increasing with stream discharge due to the wash-off and transport of larger quantities of suspended sediment with increasing flow; (C) curve showing that, at low to moderate levels of flow, phosphorus is released to the stream at a relatively constant rate, and concentrations of total phosphorus are diluted with increasing discharge. At higher levels of flow, the wash-off and transport of greater quantities of phosphorus lead to increases in concentrations of total phosphorus with increasing discharge. (From Hirsch and others, 1991.)

when a solute, sediment, or a constituent attached to sediment is delivered to a stream primarily from overland flow from paved areas or cultivated fields, or from streambank erosion. This typically results in increasing concentrations of the water-quality constituent with increasing streamflow (fig. 2B). Some constituents can be affected by combinations of both types of processes. For example, total phosphorus may come from point sources, such as sewage-treatment plant discharges (dilution effect), and may also be derived from surface wash-off and be attached to sediment particles (fig. 2C).

Knowledge of how variations in streamflow affect specific water-quality constituents is important for water-quality trend studies. When water quality varies with streamflow and only a specific range of flows (and concentrations) has been sampled, analysis of trends in water quality at the site can be biased or results could be limited to a specific range of concentration values. To determine if the water-quality record adequately represents the range of conditions at a given site requires knowledge of the relation (or lack thereof) of concentration to streamflow and the variation of flow over time.

A significant limitation of an ungaged or partial-record site with regard to water-quality assessment is the uncertainty of the frequency and range of flow conditions which occur at the site. The relation between water quality and streamflow along with knowledge of the frequency, magnitude, and duration of flows at the site can indicate when maximum constituent concentrations and transport occur. Periods of maximum concentration may not necessarily coincide with periods of maximum transport. This information is best provided by a continuous-record gaging station and collection of water-quality samples across the range of flow conditions.

AVAILABILITY OF STREAMFLOW DATA FOR SWAMP SITES

At SWAMP sites associated with active gaging stations, streamflow data can be directly obtained from the USGS (or other agencies that maintain the active gages). The most accurate estimates of streamflow are obtained by actively monitoring streamflow at the water-quality sampling site, either by measuring streamflow at the time of water-quality sampling, or by maintaining a streamflow station with a continuous water-stage recorder and periodically verifying the stage-discharge (streamflow) relation.

Locations of the trend stations in the SWAMP network (fig. 1, plate 1) were compared to the USGS continuous-record streamflow-gaging network (plate 2), including stations active in water year 1996 (October 1995–September 1996) and inactive stations with at least 5 years of gaged record. Detailed information for active and inactive USGS stations, including drainage area and period of record, appears in appendices A and B, respectively.

The 315 SWAMP sites were classified according to their proximity to the USGS streamflow-gaging stations (plate 2). Active (water year 1996) USGS gaging stations were located at 71 SWAMP sites (table 1).

Table 1. SWAMP network trend sites where an active U.S. Geological Survey streamflow-gaging station is operated at the same location

[All USGS stations listed are continuous-record gaging stations]

SWAMP site number	USGS station number	Stream name
A6	02249007	Eau Gallie River
A9	02232500	St. Johns River
A13	02245200	Rice Creek
A17	02244440	Dunns Creek
A20	02233500	Econlockhatchee River
DEP010C1	02315200	Deep Creek
ECN010C1	02326000	Econfina River
NW03	02375500	Escambia River
NW14	02358000	Apalachicola River
NW18	02376500	Perdido Bay
NW28	02369000	Shoal River
NW32	02366500	Choctawhatchee River
NW35	02359500	Econfina Creek
NW39	02359000	Chipola River
NW42	02358700	Apalachicola River
NW47	02330100	Telogia Creek
NW49	02329000	Ochlockonee River
NW51	02327100	Sopchoppy River
SFR050C1	02321975	Santa Fe River
SJ1	02231289	Nassau River
SJ22	02235200	Blackwater Creek
SJ25	02234990	Little Wekiva River
SJ28	02234000	St. Johns River
SJ32	02232400	St. Johns River
SJ38	02243000	Orange Creek
SJ40	02240500	Oklawaha River
SJ44	02238500	Oklawaha River
SJ45	02238000	Haines Creek
SJ46	02237293	Palatlakaha River
SJ47	02237700	Apopka-Beauclair Canal
SJ49	02236500	Big Creek
SJ54	02247510	Tomoka River

Table 1.—*Continued* SWAMP network trend sites where an active U.S. Geological Survey streamflow-gaging station is operated at the same location

SWAMP site number	USGS station number	Stream name
SJ56	02248000	Spruce Creek
SO9	02286100	South New River Canal
SO12	02281400	Hillsborough Canal
SO15	02279000	C-51/W. Palm Beach Canal
SO17	02278550	Levee 8
SO18	02281200	Conservation I/Hillsborough Canal
SO20	02286700	Barron River
SO22	02301300	South Prong Alafia River
SO28	02298608	Myakka River
SO42	02270500	Arbuckle Creek
SO44	02273000	Kissimmee River
SO50B	02250030	Turkey Creek
SO55	02277000	St. Lucie Canal
SO62	02292000	Caloosahatchee Canal
SO71	02266550	Reedy Creek
SO79	02297310	Horse Creek
SO80	02294650	Peace River
SO82	02296750	Peace River
SO84	02268903	Lower end of lake/Kissimmee River
SO84	02268904	Kissimmee River
SO89	02299950	Manatee River
SO93	02301990	Hillsborough River
SO94	02303000	Hillsborough River
SO98	02313000	Withlacoochee River
SO112	02310280	Pithlachascottee River
SO113	02310000	Anclote River
SO115	02310500	Weeki Wachee Spring
SO124	02235000	Wekiva River
SO127	02233200	Little Econlockhatchee River
SO132	02291000	Barron River
SO138	02288900	Tamiami Canal
SO139	02256500	Fisheating Creek
SO143	02288600	Miami Canal
SO154	02289050	W. Dade/Tamiami Canal
SUW010C1	02315000	Suwannee River
SUW070C1	02315550	Suwannee River
SUW100C1	02319500	Suwannee River
SUW140C1	02320500	Suwannee River
SUW160C1	02323500	Suwannee River

Inactive USGS gaging stations were located at 18 SWAMP sites (table 2). There were 60 SWAMP sites with a nearby active USGS gaging station on the same stream (table 3) and 28 SWAMP sites with a nearby inactive station on the same stream (table 4). There were 142 SWAMP sites with no nearby USGS gaging station on the same stream (table 5). Some of the 315 SWAMP sites had both coincident inactive and nearby active USGS gaging stations, and some SWAMP sites had multiple nearby USGS gaging stations.

Beginning in water year 1997, the USGS will establish 8 gaging stations located at or near SWAMP sites. Six of these sites have previous records (see appendix B) and two will be new sites.

Continuous-record stations collect data at regular intervals, generally every 15, 30, or 60 minutes. The USGS streamflow data are published in annual data reports (for example, Franklin and Meadows, 1995) which include daily, monthly, and annual mean flows, and annual and monthly high- and low-flow values, in addition to other important information, including the estimated accuracy of the record. This information is accessible from the USGS District office, Tallahassee, Fla., and, for selected stations, online through the Internet (http://fl-water.usgs.gov). Some of the inactive USGS gages are currently operated by other agencies, such as the Florida water management districts; thus, more recent or current gaged records might be available elsewhere.

Table 2. SWAMP network trend sites where an inactive U.S. Geological Survey streamflow-gaging station once operated at the same location

[All USGS stations listed are continuous-record streamflow-gaging stations with 5 or more years of record]

SWAMP site number	USGS station number	Stream name	End of record (year)
ALA010C1	02317620	Alapaha River	1987
AUC05	02326500	Aucilla River	1982
NW04	02370000[1]	Blackwater River	1992
NW08	02365200	Choctawhatchee River	1981
NW20	02376100	Marcus Creek	1991
NW23	02376033[1]	Escambia River	1994
NW24	02370500	Big Coldwater Creek	1991
ROB010C1	02315392	Robinson Creek	1981
ROK001C1	02314986	Rocky Creek	1983
SJ3	02231253	St. Marys River	1989
SO70	02263500	St. Cloud Canal	1968
SO142	02286340	Biscayne Canal	1985
SO146	02287500	Miami Canal	1979
SO148	02286300	Snake Creek	1985
SUW130C1	02320000[1]	Suwannee River	1937
SUW150C1	02323000	Suwannee River	1956
SWF010C1	02315520	Swift Creek	1988
WAC00	02313500	Waccasassa River	1953

[1] Station will be reactivated in water year 1997.

Table 3. SWAMP network trend sites where an active U.S. Geological Survey streamflow-gaging station is located upstream or downstream from the site

[USGS stations listed are continuous-record streamflow-gaging stations. * indicates Georgia sites]

SWAMP site number	USGS station number	Stream name
A8	02231600	Jane Green Creek
AUC05	02326512	Aucilla River
AUC10	02326512	Aucilla River
NEW010C1	02321000	New River
NW01	02376500	Perdido Bay
NW08	02365500	Choctawhatchee River
NW13	02343801*	Chatahoochee River
NW15	02329600	Little River
NW16	02329342*	Attapullus Creek/Little Attapulgus Creek
NW17	02330000	Ochlockonee River
NW19	02376115	Elevenmile Creek
NW44	02358754	Apalachicola River
NW45	02359170	Apalachicola River
SFR020C1	02320700	Santa Fe River
SFR060C1	02322500	Santa Fe River
SJ4	02228500	St. Marys River/N. Prong St. Marys River
SJ5	02244040	St. Johns River
SJ14	02246300	Ortega River
SJ19	02236000	St. Johns River
SJ23	02235000	Wekiva River
SO8	02286200	Snake Creek
SO21	02301000	N. Prong Alafia River
SO24	02301000	North Prong Alafia River
SO26	02298830	Myakka River
SO27	02298608	Myakka River
SO30	02298608	Myakka River
SO35	02299780	Phillippe Creek
SO36	02273000	Kissimmee River
SO47	02296750	Peace River
SO60	02292900	Caloosahatchee River
SO65	02292900	Caloosahatchee Canal
SO73	02262900	Boggy Creek
SO75	02298202	Shell Creek
SO76	02296750	Peace River
SO78	02294898	Peace River
SO86	02300032	Braden River
SO91	02300100	Little Manatee River
SO92	02300500	S. Fk. Little Manatee River
SO96	02304000	Hillsborough River
SO96	02304500	Hillsborough River
SO100	02313250	Withlacoochee River
SO101	02312720	Withlacoochee River
SO102	02300700	Bullfrog Creek
SO103	02307000	Rocky Creek
SO107	02310947	Withlacoochee River
SO108	02312000	Withlacoochee River
SO109	02312000	Withlacoochee River
SO110	02310000	Anclote River
SO122	02264000	Cypress Creek
SO125	02263800	Shingle Creek
SO126	02234990	Little Wekiva
SO128	02291673	Tenmile Canal
SO140	02256500	Fisheating Creek
SO144	02290710	Black Creek
STN020C1	02324000	Steinhatchee River
STN031C1	02324000	Steinhatchee River
STN040C1	02324000	Steinhatchee River
UNK3	0223129985	ICW Sisters Creek/Cedar Point
WAC00	02313700	Waccasassa River
WIT010C1	02319000	Withlacoochee River
WIT040C1	02319000	Withlacoochee River

Table 4. SWAMP network trend sites where an inactive USGS streamflow-gaging station once operated upstream or downstream from the site

[USGS stations listed are continuous-record streamflow-gaging stations with 5 or more years of record]

SWAMP site number	USGS station number	Stream name	End of record (water year)
HNT010C1	02315005	Hunter Creek	1988
NW02	02376300	Brushy Creek	1991
NW05	02368000[1]	Yellow River	1993
NW08	02365200[1]	Choctawhatchee River	1981
NW09	02366000	Homes Creek	1981
NW21	02376000	Pine Branch	1994
NW25	02370700	Pond Creek	1979
NW26J	02370200	Big Juniper Crk	1967
NW31	02367000	Alaqua Creek	1978
NW31	02367006	Alaqua Creek	1994
NW50[2]	02330300	New River	1981
NW53	02326900[1]	St. Marks River	1990
SJ13	02246359	Cedar Creek/River	1994
SJ37	02242451	Orange Lake/outlet	1995
SO10	02285000	North New River Canal	1992
SO11	02282100	Cypress Creek Canal	1985
SO37	02272500	Kissimmee River	1964
SO38	02272500	Kissimmee River	1964
SO53	02277700	22 C-18/Lovahatchee	1965
SO69	02267500	Kissimmee River	1968
SO72	02265000	Lake Toho/S. Port Canal	1968
SO83	02269000	Kissimmee River	1969
SO88	02300000	Manatee River	1966
SO95	02303300	Flint Creek	1991
SO131	02291300	Golden Gate Canal	1984
SO133	02291270	Henderson Creek	1984
SO135	02291143	Faka Union Canal	1984
SO141	02259200	Indian Prairie Canal	1989
SO141	02259500	Indian Prairie Canal	1950
SO151	02290725	C-103/Mowry Canal	1989
SO155	02290560	Coral Gables Canal	1970

[1] Station will be reactivated in water year 1997.

[2] New nearby USGS streamflow-gaging station will be established in water year 1997.

Table 5. SWAMP network trend sites with no nearby continuous-record U.S. Geological Survey streamflow-gaging stations

[USGS lake gaging stations, which monitor water-level elevations and might occur near SWAMP lake sites, were not included in this study]

SWAMP site number	Site name
A1	Harris Lake
A2	Lake Eustis
A3	Lake Griffin
A4	Yale Lake
A5	Lake Weir
A7	Indian River Lagoon
A11	Moncrief Creek
A14	Tolomato River
A16	Matanzas River
A18	Lake Jessup
CMP010C1	Camp Branch
ECN00	Econfina River
ECN01	Econfina River
ICH010C1	Ichetucknee River
NW06	Pond Creek
NW07	Horsehead Creek
NW10	Wright Creek
NW11	Marshal Creek
NW12	Cowarts Creek
NW22	Canoe Creek
NW26T	Telogia Creek
NW27	Trammel Creek
NW29	East Bay River
NW30	Carpenters Creek
NW33	Bruce Creek
NW34	Sandy Creek
NW36	Sandy Creek
NW37	Bayou George Creek
NW38	Chipola River
NW40	Dead Lakes
NW41	Sutton Creek
NW43	Mosquito Creek
NW46[1]	New River
NW48	Telogia Creek
NW52[1]	Ochlockonee River
NW54	Wakulla River
NW55	Munson Slough
OLS010C1	Olustee Creek
ROR010C1	Roaring Creek
SFR040C1	Santa Fe River
SFR070C1	Santa Fe River
SJ2	Nassau River
SJ7	Crescent Lake
SJ9	Georges Lake
SJ12	Kingsley Lake
SJ15	Julington Creek
SJ24	St. Johns River
SJ26	Lake Jessup
SJ27	Center Lake
SJ29	Big Econlochatchee River
SJ30	Big Econlochatchee River
SJ31	Jim Creek
SJ33	St. Johns River
SJ34	Blue Cypress Lake
SJ35	Hatchet Creek
SJ36	Sweetwater Branch
SJ48	Cherry Lake
SJ50	Indian River
SJ51	Turnbull Creek
SJ52	Indian River
SJ53	Tomoka River
SJ55	Halifax River
SMR010C1	Sampson River
SO01	Lake Okeechobee
SO02	Lake Okeechobee
SO03	Lake Okeechobee
SO04	Lake Okeechobee
SO05	Lake Okeechobee
SO06	Lake Okeechobee
SO07	Lake Okeechobee
SO13	Upstream of S40 on C-15
SO14	Upstream of S41 on C-16
SO16	Upstream of S44 on C-17
SO19	Pump station
SO23	S. Prong Alafia River
SO25	Alafia River
SO31	Lemon Bay
SO32	Curry Creek
SO33	Main A Canal
SO34	Cow Pen Slough
SO39	Outflow Structure
SO41	Lake Istokpoga
SO43	Arbuckle Creek
SO45	Lake Istokpoga
SO46	Charlotte Harbor
SO49	Indian River
SO50A	Turkey Creek
SO51	Indian River
SO54	S. Fork St. Lucie River
SO56	Upstream of Weir S48
SO57	Upstream of S49
SO58	Upstream of Weir S50
SO59	N. Fork St. Lucie River
SO64	Telegraph Creek
SO66	Lake Marian
SO68	Lake Weohyakapka
SO74	Alligator Lake
SO77	Oak Creek
SO81	Peace River
SO85	Lake Jax Center
SO87	Gamble Creek
SO90	N. Fork Manatee River
SO97	Itchepackesassa Creek
SO99	Blue Run Rainbow River
SO104	Lake Alice
SO106	Lake Mattie
SO111	Green Key
SO114	Hunter Lake
SO116	Weeki Wachee River
SO117	Lake Tooke
SO118	Boggy Creek
SO119	St. Johns River
SO120	Econlockhatchee River
SO121	Econlockhatchee River
SO123	Lake Sheen
SO129	Lake Trafford
SO130	Gordon River
SO136	Turner River
SO137	Lely Creek
SO145	Cent. Shark Slough
SO147	C-111 Canal
SO149	C-4
SO150	C-1
SO152	Little River Canal
SO156	Shingle Creek
SO157	Lake Livingston
SO158	Lake Hatchineha
SO159	Little Withlacoochee
SUW090C1	Suwannee River
SUW120C1	Suwannee River
SUW240C1	Suwannee River
UNK1	ICW: Amelia River
UNK2	ICW: Amelia River
UNK4	ICW: Beach Blvd
UNK5	ICW: Marsh Landing
UNK6	ICW: CM 2 - Palm Valley
UNK7	ICW: CM 21
UNK8	ICW: Robinson Creek
UNK9	ICW: just North of SR 206
UNK10	ICW: CM - Long Creek
UNK11	ICW: CM 1 - N. Fox Cut
UNK12	ICW: CM 19

[1] New nearby USGS streamflow-gaging station will be established in water year 1997.

Some statewide and regional reports that summarize historical information for USGS streamflow stations include flow duration (Foose, 1983), as well as low flows (Giese and Franklin, 1996b, Rumenik and Grubbs, 1996a,b) and peak flows (Bridges, 1982; Foose, 1983; Giese and Franklin, 1996a) with specific recurrence intervals. Flow duration refers to the average duration of specific flow rates in a given stream over the period of gaged record, presented as the percentage of the time that the flow is equaled or exceeded in that particular stream. High- (or peak) flow and low-flow frequency are usually presented as flows with an estimated probability of occurrence. High flows are described, by convention, in terms of exceedance probability and low flows in terms of nonexceedance probability. For example, an annual flood peak with a probability of occurrence of 0.1 has a 10-percent chance of being equaled or exceeded in any one year. Conversely, the 7-day annual low flow with a probability of occurrence of 0.1 has a 10 percent chance of not being exceeded in any one year.

METHODS FOR ESTIMATING STREAMFLOW AT UNGAGED SITES AND PARTIALLY GAGED SITES

The most accurate method for determining streamflow for SWAMP sites is to measure streamflow at the time of sampling or to maintain a continuous-record gaging station onsite. When streamflow at a SWAMP site is not continuously gaged, there are several methods that can be used to estimate instantaneous or daily mean streamflow corresponding to the time of water-quality sampling. These methods require either a transfer of information from gaged sites to ungaged sites or periodic measurements of stage (water level) and streamflow at the ungaged sites. In some areas, such as in the region of Florida approximately south of Lake Okeechobee, generalized streamflow-estimation techniques for ungaged sites would probably not be feasible due to extensive regulation and alteration of the natural drainage network and widespread tidal effects.

In this report, streamflow-estimation methods are described for three different situations: (1) ungaged sites with nearby continuous-record gaging stations; (2) partial-record sites where periodic discharge measurements have been made; and (3) ungaged sites without nearby gaging stations or partial records (fig. 3). These methods have specific data requirements and limitations (table 6), such as the availability of nearby gaging-station records or collection of streamflow measurements at the site. Some methods are unsuitable for all flow conditions; others are unsuitable for basins with certain physiographic or hydrologic features, such as extensive flood plains, tidal influence, karst features, and significant spring inflow.

Information on factors affecting streamflow, including geologic conditions and human influences such as regulation and water use, is important for evaluating the suitability of sites for streamflow estimation. Rumenik (1988) and Choquette and others (1997) discuss some regional factors in Florida affecting mean annual and low-flow conditions, some of which may also apply to medium- and high-flow conditions. For evaluating potential spring flow input to streams, Rosenau and others (1977) and Rosenau and Faulkner (1975) summarized information on springs throughout Florida.

Estimation Method for Sites with Nearby Streamflow-Gaging Stations

The flow-routing method uses drainage areas to extrapolate or "route" streamflow values from nearby gaged sites to the ungaged site on the same stream. The flow-routing method is the easiest of all methods to apply, in terms of time and data requirements, but there is no measure of the accuracy of these estimates at ungaged sites where no streamflow measurements have been made. If periodic measurements of streamflow exist at the ungaged site concurrent with measurements at the gaged site, the accuracy of the flow-routing method can be evaluated by considering factors discussed in the section that follows.

Requirements and Limitations

The flow-routing method requires determination of drainage area and is limited to sites where diversion or regulation of flow does not occur between the gaged and ungaged sites. The method is best suited to steady-state flow conditions and to hydrologic environments where drainage areas can be accurately delineated and stream channels are well defined, with minimal storage in flood plains and lakes. Streamflow estimates based on this method should be closely evaluated in areas of Florida with extensive flood plains, numerous lakes, springs, or karst features, or when flow conditions are rapidly changing in response to stormwater input.

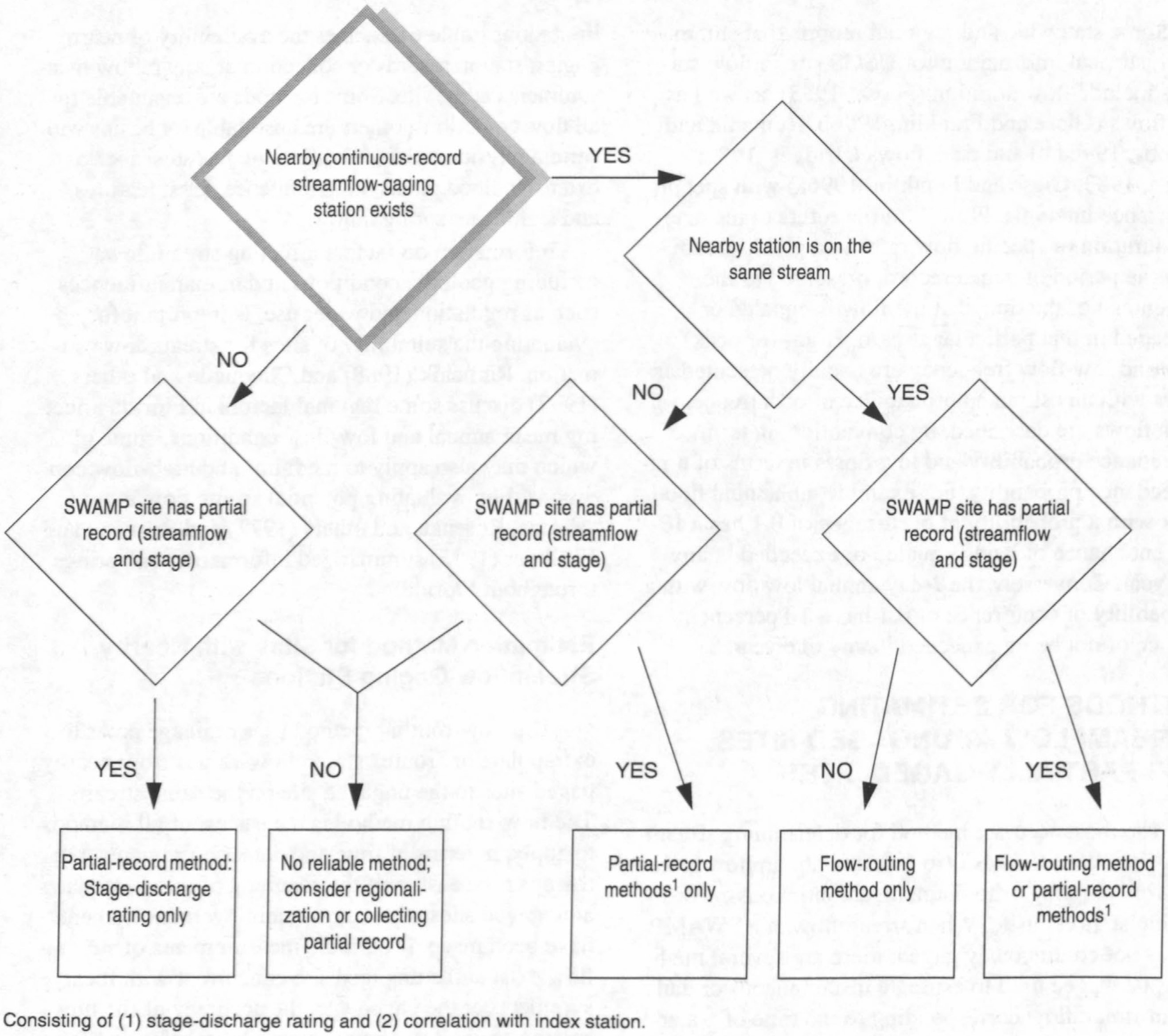


Figure 3. Decision tree for selecting streamflow-estimation methods. Partial record refers to intermittent measurements of streamflow (discharge) and stage.

Without concurrent gaging records at both the SWAMP site and the gaging site, there is no direct indicator of the error associated with the streamflow estimate. In addition, errors will probably vary during different flow conditions. For example, if the area between the gaged and ungaged sites contributes proportionally less flow during low flows and proportionally more flow during high flows than does the rest of the basin, the error associated with the estimates would vary depending on streamflow. Differences in precipitation distribution or basin characteristics, such as soils, geology, vegetation, and land use between the sites, could cause errors when the contribution of streamflow per unit drainage area varies between the gaged and ungaged site. One approach to evaluating such differences between two gaged sites is to plot the ratio of unit streamflow (flow, in cubic feet per second, divided by drainage area, in square miles) at gage 1 to unit streamflow at gage 2 versus streamflow at one of the sites. For flows at which the ratio of these values differs from one, the unit streamflow differs between the respective drainage areas as a result of nonsteady stormwater flows, differing basin characteristics, or variation in rainfall distribution.

Table 6. Summary of streamflow-estimation methods, including requirements and limitations

Method	Requirements and Limitations
1. Flow routing based on drainage area ratios	* Drainage area must be known. * Flow measurements are not required at ungaged site. * Requires steady-state or near steady-state flow conditons (low to upper medium flows). * Must have nearby gaging station on the same stream. * No flow regulation or diversion can occur between gaged and ungaged site. * Error is unknown. * In karst areas and areas of large storage (lakes, flood plains, swamps), errors can be significant. * Limitations regarding distances and area of extrapolation (difference between drainage areas of gaged and ungaged basins) will vary according to desired accuracy and hydrologic conditions.
2. Partial-record (a) Stage-discharge rating	* Requires periodic on-site flow and stage measurements over range of target flows. * Can be used to estimate all (including high) flow conditions. * No nearby gaging stations necessary. * Requires measurement of stage and verification of stage control for each estimation. * The most accurate of the flow estimation methods, if all requirements are met.
(b) Correlation with index station	* Requires periodic on-site flow measurements over range of target flows. * Must have nearby continuous-record gaging station (on the same stream or on a nearby stream) that provides good correlation for target flow conditions. * Estimation of high flows may have large errors or may not be feasible due to poor correlation during nonsteady flow conditions.
3. Regionalization	* Applies only to streamflow statistics, not instantaneous or daily mean flows. * Restricted to nonregulated streams and sites with known drainage areas. * Flow measurements are not required at ungaged site. * Requires interpretive analysis of existing data to calculate flow statistics, to define hydrologic regions, and to develop predictive models. * Delineation of hydrologic regions could be useful for locating candidate continuous-record index stations to correlate with partial-record sites.

Generally, increasing the distance between the ungaged site and the gaged site will increase the error of the estimate. This is due not only to changes in drainage basin characteristics (spatial error), but also to variations in climatic factors affecting flow (spatial and time error), such as storm patterns, and to time of travel of streamflow from one point on the stream to another (time error).

The flow-routing method is not recommended for high-flow conditions. The method is more accurate for low and medium flows than for high flows. Sauer (1973) discusses some of the physical processes involved with routing stormwater flows downstream. During periods of stormwater runoff, flows can vary considerably over space and time. Therefore, in a given hydrologic region, the errors of estimates for constant flow conditions during low to medium flows for drainage-area ratios (ungaged drainage area/gaged drainage area) of 0.25 and 4, for example, might be comparable to errors for drainage-area ratios of 0.5 and 2.0 during high-flow conditions when flows are rapidly changing.

Knowledge of the local surface- and ground-water system is important because abrupt changes in the streamflow-drainage area ratio can occur over short distances, particularly in karstic regions of Florida where surface-water divides may not be indicative of the contributing drainage area for the basin. For example, ground-water basins may not coincide with surface-water basins, and the boundaries of the ground-water basins may be transient (change with flow conditions).

Application of the flow-routing technique may require that limits be set for the ratio of the ungaged to gaged drainage areas and for the distance between gaged and ungaged sites to restrict the error of the estimates. Such limits would probably vary by region and by flow conditions, and the desired accuracy for specific study objectives. For example, in estimating low flow statistics in Virginia, Hayes (1990) limited the ratio to between 0.25 and 4.0; that is, the ungaged drainage area could range from 25 percent to 400 percent of the gaged drainage area.

In some cases, streamflow can decrease rather than increase in a downstream direction. For example, peak flow statistics for some sites on the Apalachicola River (Bridges, 1982) and on the Suwannee and Santa Fe Rivers (Giese and Franklin, 1996a) decrease in a downstream direction (fig. 4). These decreases in peak discharges were attributed to increasing flood-plain storage downstream, peak attenuation as cross sectional area of the stream channel increases downstream, and transient streamflow losses to springs that at high stream levels may effectively become sinks. Rumenik and Grubbs (1996b) also described downstream decreases in low-flow statistics for several locations on the Santa Fe River and its tributaries.

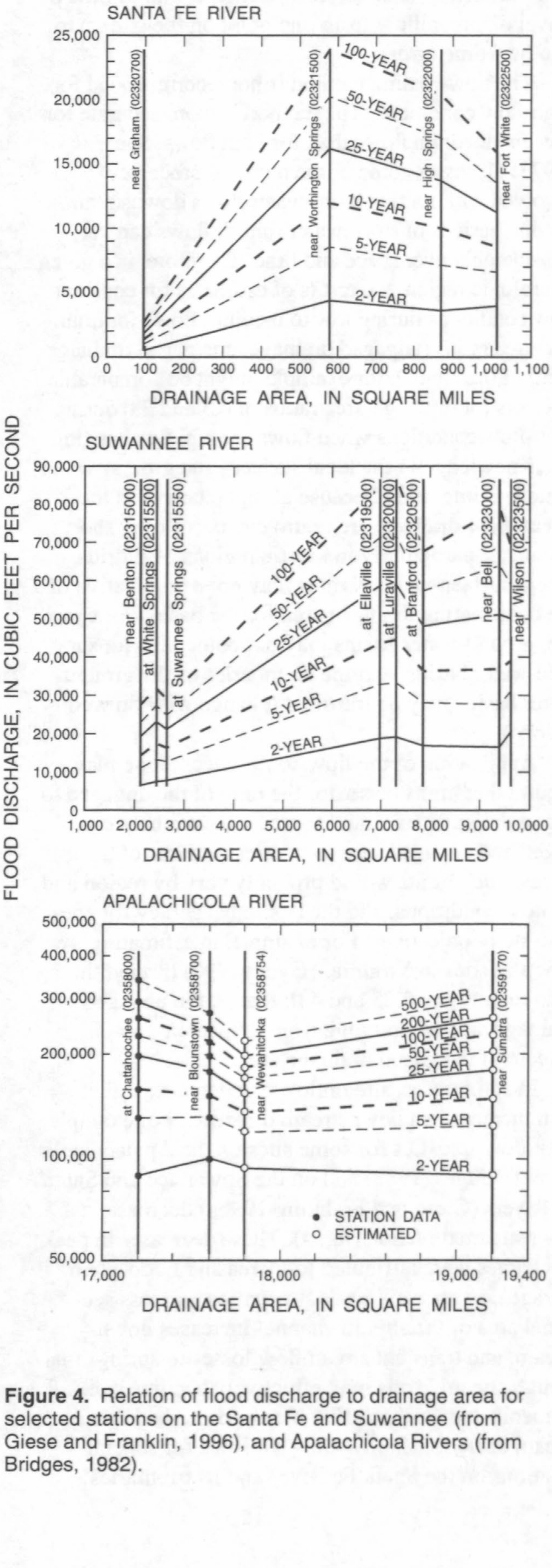


Figure 4. Relation of flood discharge to drainage area for selected stations on the Santa Fe and Suwannee (from Giese and Franklin, 1996), and Apalachicola Rivers (from Bridges, 1982).

Application of the Method

If a tributary enters between the gaged and ungaged site, streamflow values are estimated to a point at the confluence and adjustments are made to account for the change (increase or decrease) in flow. If an ungaged site is located between two gaged sites, a weighted average of the drainage areas may also be considered in the analysis.

To determine the streamflow at an ungaged site with a nearby gaged site on the same stream, the following steps are used: (1) locate the nearest gaged site; (2) determine the drainage area of the gaged and the ungaged sites; and (3) divide the streamflow value at the gaged site by the drainage area at the gaged site, then multiply by the drainage area at the ungaged site. The flow-routing equation for estimating streamflow consists of a simple drainage-area ratio:

$$Q_{un} = (Q_{ga}/AREA_{ga}) \times (AREA_{un}) \qquad (1)$$

where

Q_{un} = the estimated discharge for the ungaged site,
Q_{ga} = the discharge at the gaged site
$AREA_{ga}$ = the drainage area upstream of the gaged site, and
$AREA_{un}$ = the drainage area upstream of the ungaged site.

An example application follows: Determine daily mean discharge for SWAMP site SO76 (Peace River at Bridge 1.5 mi west of Gardner) on June 15, 1994 (fig. 5). To obtain streamflow estimates for this SWAMP site, several approaches can be used. Nearby USGS gaging stations include Peace River at Zolfo Springs (map ID 293), Charlie Creek near Gardner, (map ID 295), and Peace River at Arcadia (map ID 296) (fig. 5).

Discharge on June 15, 1994, and drainage area at these sites are: Peace River-Zolfo (map ID 293) 276 ft^3/s; 828 mi^2, Charlie Creek-Gardner (map ID 295) 303 ft^3/s; 330 mi^2, and Peace River-Arcadia (map ID 296) 644 ft^3/s; 1,367 mi^2.

The first approach is to route streamflow downstream using the Peace River-Zolfo and Charlie Creek-Gardner stations. Streamflow should be routed to the confluence of the Peace River and Charlie Creek. Streamflow of the Peace River at the confluence with Charlie Creek (drainage area = 868 mi^2) is determined using data for Peace River-Zolfo and equation (1): $Q_{un} = (276 / 828) \times 868 = 289$ ft^3/s. Next, streamflow at the mouth of Charlie Creek (drainage area = 334 mi^2), where it meets the Peace River, is: $Q_{un} = (303 / 330) \times 334 = 307$ ft^3/s.

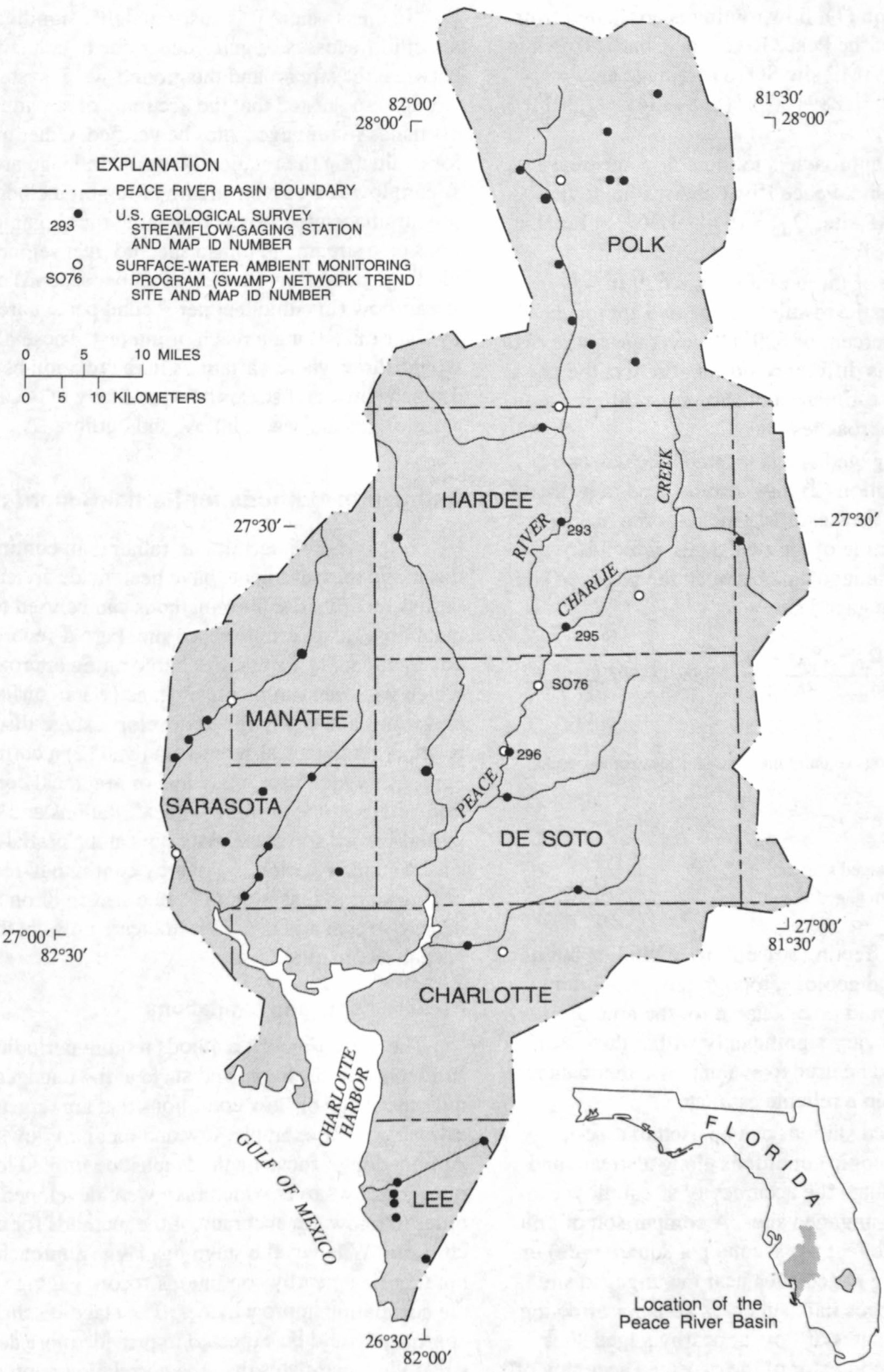


Figure 5. Locations of U.S. Geological Survey streamflow-gaging stations and SWAMP (Surface-Water Ambient Monitoring Program) network trend sites in the Peace River Basin, Florida.

By using equation (1), flow routing is continued from the confluence of the Peace River and Charlie Creek to the ungaged SWAMP site SO76 (drainage area = 1,301 mi^2): $Q_{un} = [(289+307) / (868+334) \times (1,301)] =$ 645 ft^3/s.

The second approach is to route flow upstream from the gaged site, Peace River at Arcadia, to the ungaged SWAMP site, $Q_{un} = (644 / 1,367) \times 1,301 =$ 613 ft^3/s.

The average of these estimates is 629 ft^3/s. The difference in the results of these two approaches is 32 ft^3/s, or 5.1 percent of 629 ft^3/s (average of the two approaches). This difference does not reflect the percent error of the estimates but shows the difference in using the two approaches.

When an ungaged site is located between two gaged sites, equation (2) may also be used to estimate streamflow. The flow estimate includes the average flow per square mile of the two gages, which is applied to the drainage area between the ungaged site and the upstream gaged site.

$$Q_{un} = Q_{up} + \frac{Q_{dn} - Q_{up}}{AREA_{dn} - AREA_{up}} \times (AREA_{un} - AREA_{up}) \qquad (2)$$

where

Q = Instantaneous or daily mean streamflow, for a specific date/time;

$AREA$ = drainage area;

un = ungaged site;

up = upstream gaged site; and

dn = downstream gaged site.

The factors affecting streamflow, including but not limited to surficial geology, topography, vegetation, and land use, should be evaluated for the area of interest. If conditions vary significantly within the basin, judgement should be used to evaluate whether data are sufficient to obtain a reliable estimate.

Data for gaged stations can be used to assess changes in hydrologic conditions along a stream and to indirectly evaluate the accuracy of streamflow estimates for nearby ungaged sites. A comparison of unit streamflow (cubic feet per second per square mile) on a given date using gaged sites near the ungaged site can indicate changes in basin characteristics affecting streamflow. Estimates of flow at nearby gaged sites could provide an indicator of the expected accuracy of the estimates using this method at the ungaged site. This should be done at a variety of flow conditions to determine if the error changes with streamflow.

In areas where it is suspected that significant streamflow losses or gains occur due to connections between the stream and the ground-water system, it is strongly suggested that the accuracy of streamflow estimates for ungaged sites be verified. Other methods for evaluating the relation between drainage area and streamflow for a given stream or region include plotting drainage area versus discharge for all gaging stations on a stream or along a specific river segment, and plotting streamflow (in cubic feet per second) or unit streamflow (in cubic feet per second per square mile) by river mile along a reach of interest. These plots would show where variations in the relation between drainage area and streamflow are likely to occur, and areas of ground-water inflow and outflow.

Estimation Methods for Partial-Record Sites

Sites where intermittent, rather than continuous, discharge measurements have been made are called partial-record sites. Two methods can be used to estimate flows at a partial-record site. Partial-record methods include: (1) a stage-discharge rating approach which uses measurements of stage (water-surface elevation) and discharge to develop a stage-discharge relation at the partial-record site; and (2) a correlation approach which uses analytical or graphical correlation between one or more "index" stations and the partial-record site to estimate flow at the partial-record site. An index station is a nearby continuous-record gaging station that is on the same stream or on a nearby stream and is used to indicate flows at the partial-record site.

Requirements and Limitations

The partial-record methods require periodic measurements of discharge and stage at the ungaged site over the range of flow conditions that are targeted for estimation; for example, low and medium flows. Application of these methods must be limited to the range of flows over which they were developed in order to know the accuracy of the methods for a specific site. Whereas the stage-discharge approach does not require a nearby continuous-record gaging station, the correlation approach does. The stage-discharge approach would be expected to provide more accurate streamflow estimates than the correlation approach if it is developed using a sufficient number of accurate measurements to define the rating over the range of target flows.

The stage-discharge rating approach recommends a minimum of 10 discharge measurements (control points) per year for USGS gaging stations unless the stage-discharge relation is not varying over time (Rantz and others, 1982b). More numerous measurements are recommended during initial establishment of the station. The number of control points required vary by site, depending on the variability of the stage-discharge relation, but a sufficient number of control points should be used to define the rating over the target flow conditions with the desired level of confidence. For example, in cooperation with the North Carolina Department of Natural Resources, the USGS is obtaining quarterly stage and discharge measurements to estimate streamflow from stage measurements made at water-quality monitoring sites sampled monthly in North Carolina (Jeanne Robbins, U.S. Geological Survey, Raleigh, N.C., oral commun., September 20, 1996).

The stage-discharge rating approach requires accurate measurements of water stage, ongoing assessment of upstream and downstream factors controlling the water stage at the site, and periodic measurements of discharge to verify that the stage-discharge relation has not changed over time. If rating curves must be extrapolated outside the range of measured discharges, Rantz and others (1982b) discuss some methods for reducing the uncertainty of the discharge estimates.

The correlation approach requires a sufficient number of flow measurements to evaluate the correlation over the targeted range of flows, and periodic measurements over time to verify that the correlation has not changed. The error of the estimates from this approach will depend on how closely the flows at the partial-record site correlate with flows at the index site. As with the stage-discharge rating approach, estimates are limited to the range of flows measured at the site.

Application of the Methods

The stage-discharge approach is discussed in detail by Rantz and others (1982b). The stage-discharge relations are usually developed graphically by using rectangular-coordinate or logarithmic plotting paper. Information on channel features controlling the stage-discharge relation, which usually vary between high and low flows, and changes (shifts) in these controls over time must be incorporated into the rating curve. Also, special methods must be used for sand-channel streams (Rantz and others, 1982b), as opposed to more stable-channel streams. The stage-discharge approach requires ongoing periodic measurements of stage and discharge at the partial-record site to maintain and verify the rating curve, and to apply adjustments when necessary.

Rantz and others (1982a) discuss methods for obtaining the necessary discharge and stage measurements. If water-quality samples are not collected during specific flow conditions such as high flows, there is no need to determine the stage-discharge relation for these conditions. Measurement of high flows usually requires more time and resources than measurement of medium and low flows. However, high flows are often the periods of maximum concentrations or transport for some water-quality constituents, and therefore are important for water-quality assessment.

The correlation approach uses the relation between concurrent flow measurements at a partial-record site and a nearby continuous-record index station (on the same stream or on a nearby stream) to estimate flows at the partial-record station. This relation could be expanded to include more than one index station as well as other data, such as precipitation (Searcy, 1960). If an acceptable relation exists, streamflow at the partial-record site can be estimated from concurrent streamflow data for the index site. Two types of regression methods that have been used for this approach include analytical regression techniques (Hirsch, 1982), generally used for larger data sets, and graphical regression techniques (Searcy, 1960; Riggs, 1972), generally used for small data sets, for example with fewer than 10 data points (Rumenik and Grubbs, 1996a). The relation between two gaging station records often differs for high flows as compared to the relation for low flows. For many streams in the eastern United States, this change in the relation occurs between one and two times the average discharge (Searcy, 1960). Discharge exceeding twice the average flow generally represents upper medium to high flows.

The accuracy of the correlation between two sites can decrease during high flows, as a result of factors such as unsteady flow conditions, movement of peak flows downstream, and variable storm rainfall across a region. An alternative is to use the correlation approach for low and medium flows, and to construct a stage-discharge rating for high flows.

Estimation Methods for Sites Without Nearby Streamflow-Gaging Stations

At sites without nearby gaging stations, instantaneous and mean daily streamflow cannot be reasonably determined without some onsite streamflow measurements. The stage-discharge approach, described in the previous section "Estimation records for partial-record sites," is the only viable method for estimating discharge at these sites.

For the purpose of evaluating variation in the frequency, magnitude and seasonal distribution of streamflow at these ungaged sites, streamflow statistics, such as annual or monthly mean flows, mean flow duration, high flows, and low flows, could be estimated using a regionalization approach. Regionalization is a method that uses data at gaged sites to develop regional streamflow-estimation models based on basin characteristics. By separating the study area into hydrologically distinct "regions," model errors can generally be reduced. Such an approach, however, is not likely to result in reliable estimates in the many karstic areas of the State where subsurface drainage systems complicate regionalization. In less complex areas where hydrologic regions can be defined, boundaries defining hydrologically similar areas may be useful for locating potential index stations to estimate flow at partial-record sites.

Regionalization studies in Florida have specifically focused on low-flow (Hammett, 1985; Giese and Franklin, 1996b; Rumenik and Grubbs, 1996b) and high-flow conditions (Bridges, 1982; Giese and Franklin, 1996a). The errors associated with these results vary by region and by flow statistic.

METHODS FOR ANALYZING TRENDS IN STREAMFLOW AND WATER QUALITY

The trend analysis for SWAMP sites may include streamflow, multiple water-quality constituents, and flow-adjusted water quality. All methods described here can be applied to either streamflow or water quality, except the flow-adjusted water-quality analyses, which are applicable only to water-quality trends. The methods allow for removing variability due to streamflow and/or season, which can improve the likelihood of detecting existing trends and can aid in determining causes of the trends. When both streamflow and constituent concentration are measured, the methods can be applied to either concentration, flux, or load (flux over a designated time), depending on the objectives of the analysis.

Major strengths of the selected methods include their ability to (1) maximize the use of all data in a record; (2) accommodate missing and censored (reported as less than a given detection limit) data; (3) resist disproportionate influence from outliers (unusually high or low values); (4) maximize the probability of detecting existing trends by evaluating variations due to seasonal cycles and streamflow fluctuations as part of the trend analysis; and (5) compare multiple stations in regional analyses. The ability of some methods to handle multiply-censored records is valuable for analyzing long-term water-quality records with censored values, because these records often have multiple reporting limits that reflect improvements in analytical techniques over time. Failure to account for censored values can present a serious interpretation problem, especially if the censored values exceed 5 to 10 percent of the data record (Helsel, 1990; Helsel and Hirsch, 1992, p. 352-376).

The trend methods summarized in this report are described in detail by Hirsch and others (1982), Hirsch and Slack (1984), and Helsel and Hirsch (1992). A complete analysis package for monotonic trends based on these methods, which includes data screening and plotting subroutines, is documented by Schertz and others (1991) in the software system ESTREND (EStimate TREND). These methods are used currently for regional (multistation) trend studies throughout the Water-Resources Division of the USGS, including studies conducted under the National Water-Quality Assessment (NAWQA) Program (Gilliom and others, 1995; Berndt and others, 1996). Numerous papers exist that apply the methodology to national, statewide, and regional water-quality data: for example, Alexander and Smith (1988), Liebermann and others (1989), Schertz (1990), Hay and Campbell (1991), Baldys and others (1995), and Ham and Hatzell (1996).

The trend methods are predominantly nonparametric but include some parametric methods. Nonparametric methods generally do not make assumptions about the distribution (for example, normality) of the sampled populations. The nonparametric methods use the ranks or relative values of the data, rather than the data values directly, and avoid many of the shortcomings of parametric methods when applied to hydrologic data (Hirsch and others, 1991). Hirsch and others (1991) compare the performance of these methods with alternative methods, and discuss considerations for selecting trend methods to meet specific study objectives. The power to detect existing trends and the efficiency (a measure of estimation error) of the nonparametric methods are similar to parametric approaches in the case of normally distributed data. The power and efficiency of nonparametric methods, however, become increasingly greater than for parametric methods as the data distributions deviate from normality (Hirsch and others, 1991). The nonparametric approach has significant advantages over parametric approaches when applied to multiple stations and constituents or to data that are not normally distributed. Some of these advantages include eliminating the time involved in evaluating data distributions for normality, the subjectivity of selecting appropriate transformations to achieve normality, and the potential for biasing results by applying different transformations at different sites in a regional evaluation.

For reliable trend results, data should be collected in a consistent manner over a period of at least 5 years (Hirsch and others, 1991) with a minimum of 10 observations, including at least one observation per year in the beginning and ending portions of the record. The rules for the timing of sample collection should be specified (such as monthly or quarterly sample collection) and the data should be randomly collected with respect to hydrologic conditions. The methods of sample collection, handling, shipment, preservation, laboratory measurement, and data reporting (rounding and reporting limits) should be constant over the period of record. Exceptions to these requirements can be allowed if variations in these factors have been documented to have no effect on the resulting data or if resulting biases in the data are subsequently corrected.

Data characteristics of a trend network, including sample collection and analysis techniques, periods of record, and geographic locations of stations, are important factors that can affect the outcome of a regional trend study. Schertz and others (1991) and Hirsch and others (1991) further discuss the effects of these factors on trend testing.

Selection Of Trend Test

Primary factors to consider in selecting a trend test for a given data set include: (1) the presence of large gaps in the data record, (2) significant changes in basin conditions affecting the target variable, (3) the frequency of sampling, (4) the existence of streamflow data, and (5) the occurrence of censored values in the record. These factors affect the choice of the appropriate test as well as the ability to perform adjustments for seasonal cycles and, in the case of water quality, streamflow fluctuations.

Two primary types of trends considered in hydrologic analysis are monotonic trends and step trends. Monotonic trend (one sample) analysis assesses a unidirectional change over time, whereas step-trend (two samples) analysis compares two groups of data covering specific periods of the data record. The monotonic trend analysis assumes that the population changes monotonically over time (no reversals in direction) but does not assume a linear change. The monotonic trend analysis specifies that the change be either increasing or decreasing over time but does not specify a particular pattern of change, or that it is continuous or occurs in one or more steps. The step-trend analysis evaluates whether the data collected prior to a specific time are from a different population than the data collected after that time. The monotonic trend analysis is used to determine if the data are increasing (or decreasing) over time; the step-trend analysis is used to determine if the mean or median of the two populations is different over time.

The decision to use monotonic or step-trend analysis is based on data-collection patterns and knowledge of basin conditions upstream of the particular site (fig. 6). If the data are naturally broken into two distinct periods with a relatively long time gap between them, or a known event has occurred at a specific time during the record such as construction of a wastewater-treatment plant or a dam, the step-trend method should be used. If these situations do not exist, then monotonic methods should be used.

Several factors, in addition to the desired hypothesis to be tested, will determine the particular trend test applicable to the data. A summary of the trend methods and the associated data requirements is shown in table 7. The frequency of sampling will limit the number of seasons that can be evaluated in a seasonal analysis. A value of discharge associated with the concentration is required to analyze trends in flow-adjusted concentration, flux, or loads. Different methods apply for records with a significant number of censored observations, and when multiple censoring levels exist. These factors and the appropriate application of the trend methods are discussed more fully in the following sections.

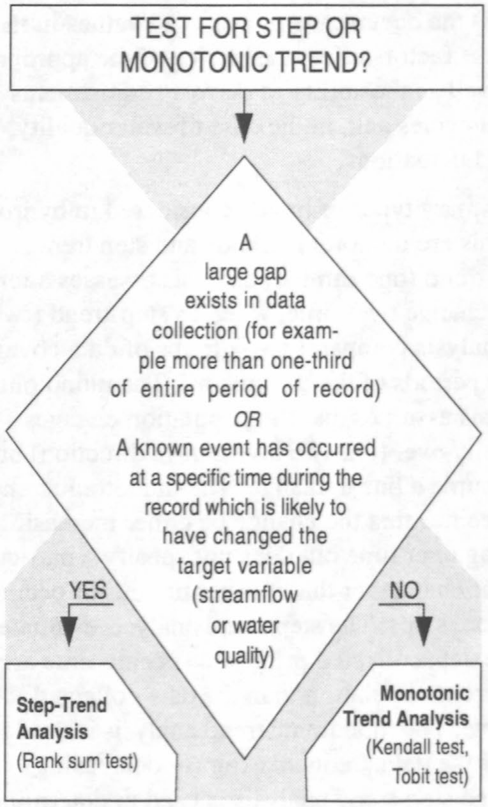


Figure 6. Decision tree for selection of step or monotonic trend method.

Monotonic Trends

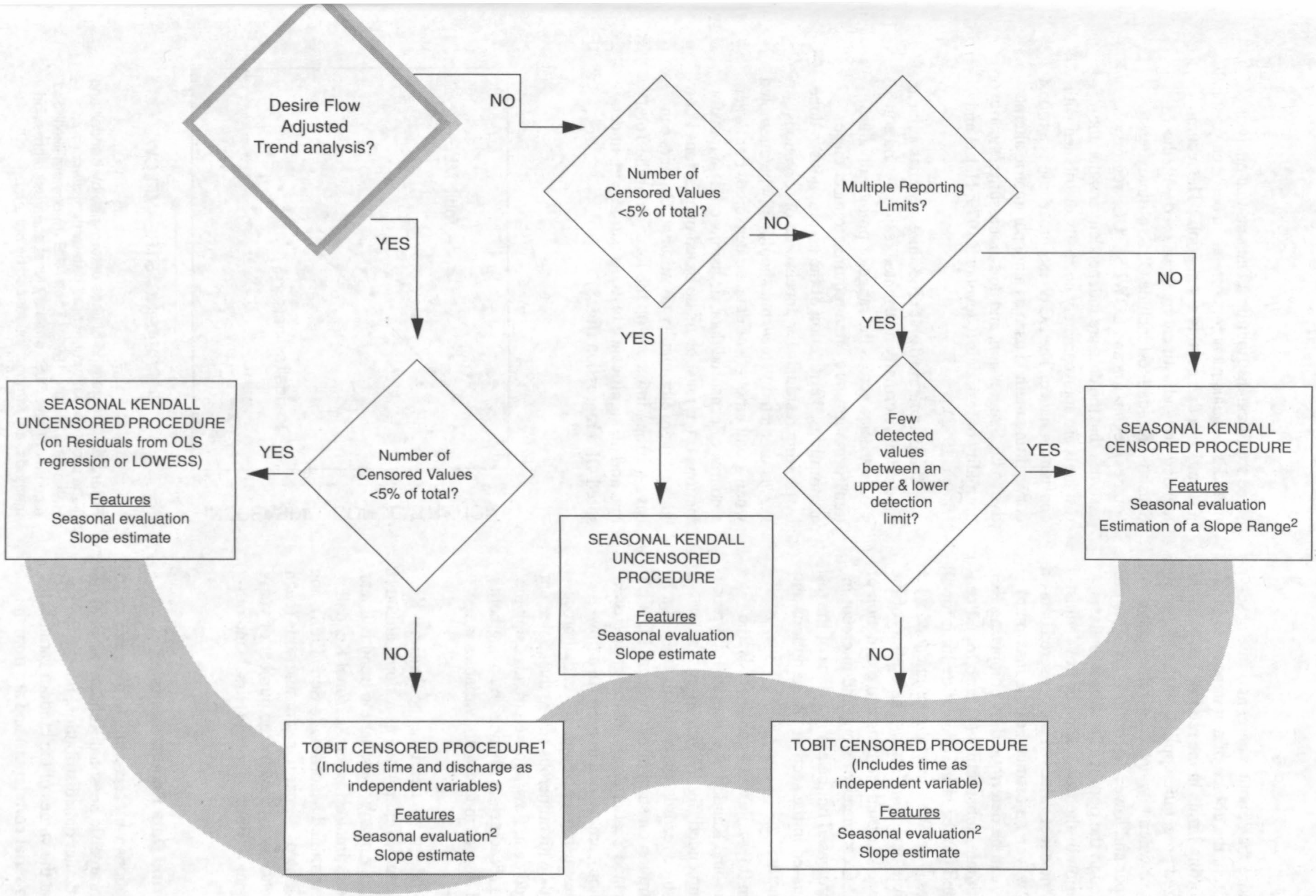
The recommended tests for monotonic trends include the nonparametric Seasonal Kendall test (Hirsch and others, 1982), which is a generalization of the Mann-Kendall test (Mann, 1945; Kendall, 1975), and the parametric Tobit test (Judge and others, 1985; Helsel and Hirsch, 1992). The Seasonal Kendall test can be used to analyze annual or seasonal trends. The Tobit procedure consists of applying the method of maximum likelihood estimation (MLE), also referred to as Tobit estimation (Hald, 1949; Cohen, 1950), to estimating the parameters of a linear regression model relating discharge, concentration, flux, or load, to time or, for flow-adjusted trends, to time and discharge. Cohen (1950, 1976) and Cohn (1988) extended the MLE method to accommodate multiple censoring levels.

A decision tree for selecting monotonic trend tests is shown in figure 7. The choice of the appropriate test, after deciding upon flow adjustment, depends primarily on the presence of censored values and the number of reporting limits for censored data (fig. 7).

Table 7. Summary of suggested requirements for applying trend evaluation methods

Method	Requirements and Limitations
1. General--applies to all methods	* At least 5 years of record. * Data were randomly collected with respect to hydrologic conditions. * Consistent methods of sample collection, handling, shipment, preservation, laboratory measurement, and reporting conventions; or an evaluation showing changes in methods did not result in significant changes in target variable. * Minimum of 10 observations in record. * At least one observation per year in beginning and ending portions (e.g., fifths) of record. * When record is divided into thirds, each third should have a minimum percentage (e.g., 20 percent) of total coverage as nonmissing data for monotonic trends, and each step should meet this specification for step trends.
2. Seasonal	* Number of observations should equal at least 3 times the number of seasons. * User should select a seasonal designation where at least 50 percent of the total number of seasons has at least 50 percent of the maximum possible number of comparisons present. * Consider evaluation of sampling frequency for selected seasonal designation using beginning, middle, and end of record (see Schertz and others, 1991). * Maximum of 12 seasons per year.
3. Flow-adjusted concentration	* Must have streamflow value corresponding to concentration for minimum number of observations required by trend test (see above). * Cannot be applied if a trend in streamflow exists. * Requires residuals (observed minus predicted concentration) from mathematical model of flow versus concentration for input to trend analysis. * No more than about 5 percent of observations in record should be censored.
4. Censored Methods	Season Kendall test (nonparametric): * No more than 1 detection limit, or when few detected values occur between the upper and lower detection limits. * Minimum number of detected observations must be at least 3 times the number of designated annual seasons, and must be greater than or equal to 10.
	Tobit test (parametric): * Allows multiple detection limits. * Minimum percentage (specified by user) of total observations should exceed highest detection limit (e.g., 20 percent).

If flow-adjusted trend analysis is not desired, the Seasonal Kendall (uncensored and censored) and censored Tobit procedures can be used (fig. 7). If less than about 5 percent of the observations are censored, the Seasonal Kendall uncensored procedure can be used.



[1] Not currently available in ESTREND for flow adjustment.
[2] Not currently available in ESTREND.

Figure 7. Decision tree for selecting monotonic trend test (modified from Schertz and others, 1991).

However, if more than about 5 percent of the observations are censored, the choice of test depends on the number of reporting limits in the record. The Seasonal Kendall censored procedure applies when there is one detection limit or when few detected values occur between an upper and lower detection limit. This procedure is limited to the option of seasonal analysis, without estimation of the trend slope or flow-adjustment, because the exact values of the censored data are not known. However, an estimate of the maximum range of slopes can be determined by computing Kendall's slope estimate, substituting (1) zero for all censored values; and (2) the largest detection limit for all censored values. The Tobit test is recommended when there are multiple detection limits. The options of the Tobit test include seasonal analysis and estimation of trend slope. MLE estimates of slope and intercept in the Tobit test are based on the assumptions of the test, which are discussed in the section "Assumptions and Data Requirements."

To perform flow-adjusted trend analysis, the uncensored Seasonal Kendall or censored Tobit procedures are recommended (fig. 7). For uncensored or minimally censored records, the residuals from regression of concentration on streamflow, or from LOWESS (LOcally WEighted Scatterplot Smoothing; discussed in the next section), are needed to perform a flow-adjusted trend test using the Seasonal Kendall procedure. For records with numerous (more than 5 percent of total) censored data, flow-adjusted trends using the Tobit censored procedure are obtained by using both streamflow and time as independent variables in the Tobit regression.

The magnitude of the trend for the Seasonal Kendall procedure can be determined as a slope, although this does not imply in any way that the trend is linear. The trend-slope estimator for the Seasonal Kendall procedure is determined according to Sen (1968), and is the median slope of all pairwise comparisons (each pairwise difference is divided by the number of years separating the pair of observations) (Hirsch and others, 1982).

Assumptions And Data Requirements

The assumptions vary according to the trend test used. The nonparametric Seasonal Kendall test does not assume any particular data distribution, but the method does assume that the values of the random variable are independent (no serial correlation) and are from the same statistical distribution. (The seasonal analysis includes an adjustment for correlation between seasonal test statistics to meet this assumption.) The recommended flow-adjustment methods used with the Seasonal Kendall test include OLS (ordinary least squares) regression and LOWESS. OLS regression assumes that the data are independent and that the residuals are approximately normally distributed with constant variance. The LOWESS procedure is a robust curve-fitting method used as a nonparametric alternative to OLS regression, and does not assume linearity or normality of residuals (Cleveland, 1979; Helsel and Hirsch, 1992).

The parametric Tobit procedure assumes a linear model with normally distributed residuals and constant variance across the range of predicted values; transformations are often required to meet these assumptions. Verification of the assumptions is done by plotting residuals for uncensored observations versus predicted values, but should only be attempted when small amounts of data are censored. For larger amounts of censored data, decisions on data transformations often must be made based on previous knowledge of the water-quality constituent. Outliers can have a strong influence on the location of the Tobit line and on significance tests, as is true with uncensored OLS regression (fig. 8).

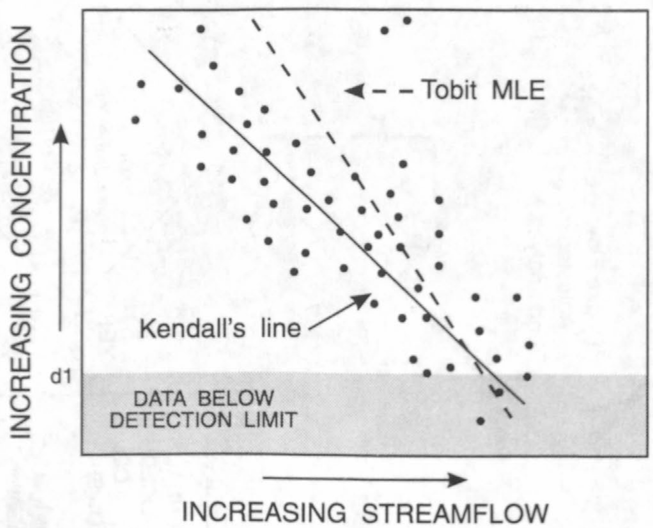


Figure 8. Comparison of lines determined by Kendall and Tobit procedures for censored data with outliers (from Helsel and Hirsch, 1992). Tobit MLE (maximum likelihood estimation) and OLS (ordinary least squares) regression methods, are strongly influenced by outliers.

The Seasonal Kendall test can accommodate missing values in the record. However, as a minimum distribution of data in the record, the following guidelines are recommended (Helsel and Hirsch, 1992). Divide the study period into thirds and determine the coverage in each period (for example, if the record is generally monthly, count the number of months for which there are data). If any of the thirds have less than 20 percent of the total coverage, then delete the site from trend testing.

For a seasonal analysis, the number of observations should equal at least 3 times the number of seasons, in addition to the requirements previously mentioned. Also the user should select a minimum number of total seasons with at least 50 percent of the maximum possible number of comparisons present (suggest 7 for monthly, 5 for bimonthly, 3 for quarterly, and 2 for biannual). For records with N years of data, the maximum number of possible comparisons per season is [N(N-1)]/2. Schertz and others (1991, p. 17-18) split the data record to evaluate the adequacy of sampling frequency for the user-selected number of seasons, where the beginning and ending periods of the record are examined separately from the middle period. For the Tobit procedure, a minimum percentage (as specified by the user) of total observations must be above the detection limit (for example, 20 percent).

Trend magnitudes or slopes from Seasonal Kendall should not be reported if more than about 5 percent of the record is censored. As an alternative for records that are significantly censored, the maximum range in slopes could be reported, as previously described. For Tobit analysis, slopes should not be reported if more than a given part of the record, as specified by the user, is censored (for example, 50 percent).

Adjustment for Season

Streamflow and many water-quality constituents are influenced by seasonal patterns in biological activity and in management practices both in the watershed and in the stream itself. The source of the streamflow or constituent may change during different seasons, resulting in changes in stream chemistry and discharge. The seasonal application of fertilizers and pesticides in urban and agricultural watersheds may result in changes in nutrients and pesticides in the streams. For this reason, Ham and Hatzell (1996) analyzed trends in nutrient concentrations in central and northeastern Florida streams using four seasons (approximately corresponding to winter, spring, summer, and fall). Streamflow may be derived predominantly from surface runoff during some parts of the year and from ground-water discharge during other parts of the year, resulting in changes to the chemistry and sediment content of the water. Ground water is typically the major source of streamflow during low-flow periods.

Seasonal patterns vary geographically. For example, the low-flow season in peninsular Florida occurs during April through June, in contrast to October through December in northern Florida (Kenner, 1969; Rumenik and Grubbs, 1996a). These geographic differences in the low-flow seasons result from differences in the seasonal distribution of precipitation and evaporation.

The Seasonal Kendall test adjusts for seasonality by separately computing the Kendall test on each of the seasons, and then combining the results (Hirsch and others, 1982; Helsel and Hirsch, 1992). For example, by using monthly "seasons," January data are compared only with January, February with February, etc., and the seasonal test statistics are summed to obtain an overall test statistic. The significance test can be modified for serial correlation between the seasonal test statistics (Hirsch and Slack, 1984). If there are random or systematic changes in sampling frequency, the data used in the trend test may need to be modified (Helsel and Hirsch, 1992). The estimate of trend magnitude in the Seasonal Kendall procedure is computed as the median of the Sen slope estimators (Sen, 1968) for each season.

The Seasonal Kendall test statistic assumes a single pattern of trend across all seasons. However, trends in different seasons may not be consistent between each other or with the overall trend. For example, weak positive trends in each month may not be significant but may result in a significant positive overall trend. Or when the overall trend is significant, significant seasonal trends may be restricted to specific months. Also, strong decreasing and strong increasing trends in different seasons may cancel each other, so that, overall, a trend is not detected. Detailed examination of results for individual stations, such as shown in figure 9, may reveal differences in trends between seasons. Also, a test for homogeneity (van Belle and Hughes, 1984) can be used to determine whether the seasonal trends are similar (homogeneous) or different (heterogeneous) (Helsel and Hirsch, 1992).

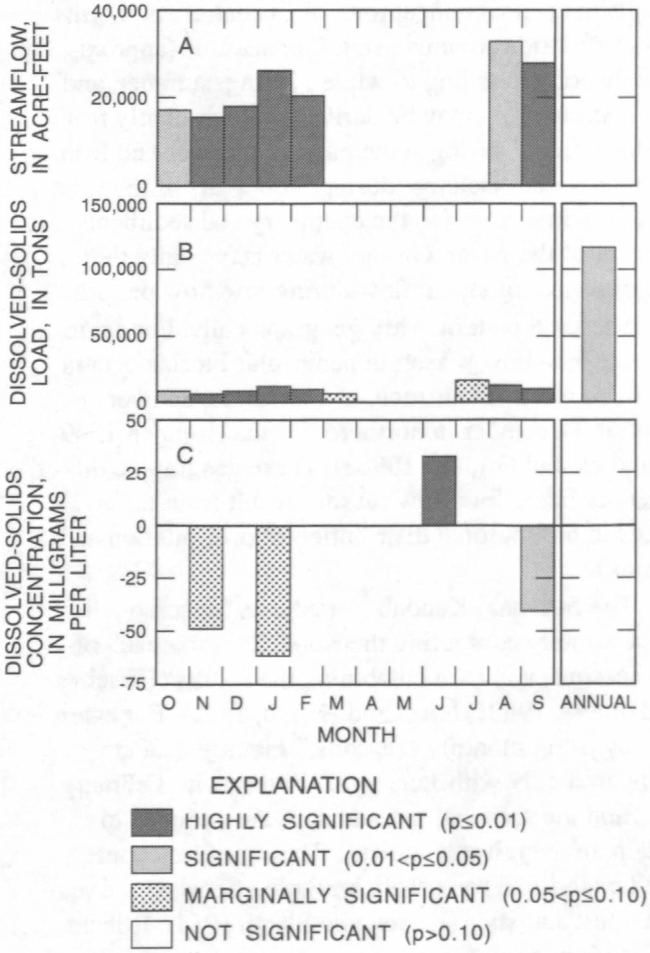


Figure 9. Comparison of trends on seasonal (monthly) and annual data for the Green River, Wyoming (from Liebermann and others, 1989); (A) some significant monthly trends, but annual trend is not significant due to high variability of annual values; (B) some months show significant positive trends and annual trend is significant for load; (C) positive and negative monthly trends, but annual trend is not significant. The rank-sum test, a nonparametric procedure, was used in this analysis. The monthly and annual trends do not include adjustment for seasonal cycles.

Adjustment for Streamflow

The variation in water quality due to streamflow variations and some of the causes of this relation were discussed earlier in the section, "Importance of Streamflow Data for Water-Quality Monitoring." To remove this variation for the purpose of trend analysis, the relation between water quality and streamflow is modeled using OLS regression or a robust curve-fitting procedure such as LOWESS. The trend analysis is then conducted on the residuals from this relation (Hirsch and others, 1991).

If the streamflow record is stationary (trend free), the results of such analysis of residuals then becomes an efficient means of detecting and estimating the magnitude of trends in the water-quality variable of interest (Hirsch and others, 1991). If the distribution of streamflow has changed over the period of analysis, a trend in these residuals does not necessarily translate into a trend in the distribution of the water-quality constituent (Hirsch and others, 1991). Thus, analysis of trends in streamflow can provide important information prior to performing flow-adjusted trend analysis. Flow adjustment should not be used where human activity has altered the probability distribution of streamflow through changes in regulation, diversion, or consumption during the period of trend analysis.

Natural, climatic-induced variation over time is another factor to consider in analyzing trends in streamflow or in flow-adjusted concentrations. Precipitation or streamflow data for the period of interest can be compared with the longer-term precipitation or streamflow record, if available, to evaluate potential differences between the short-term and long-term records.

ESTREND software (Schertz and others, 1991) provides 14 possible models for looking at the relation between concentration and streamflow. The regression models include 11 forms: linear, log-log, and various transformations of streamflow including logarithmic, hyperbolic, and inverse. Two LOWESS smooths are provided as alternatives to the regression approach. In ESTREND, only two methods are used within the 14 models: (1) regression of concentration on various functional forms of flow; and (2) a smoothed LOWESS line fitted to concentration and streamflow, or log transformations of these variables.

Step Trends

The recommended test for analyzing step trends in streamflow, concentration, flux, or load is the rank-sum test. This test is also known as the Wilcoxon test, the Mann-Whitney test, and the Wilcoxon-Mann-Whitney rank sum test, and is the nonparametric equivalent to the parametric two-sample t-test for comparing two independent samples (Conover, 1980; Iman and Conover, 1983; Helsel and Hirsch, 1992). The rank-sum test is exactly equivalent to the two-sample t-test, except that it is applied to the ranks of the data rather than to the data values themselves. The step-trend magnitude is estimated using the

Hodges-Lehmann (H-L) estimator (Hodges and Lehmann, 1963; Hollander and Wolfe, 1973, p. 75-77). This estimator is the median of all possible pairwise differences between data in the "before" and "after" periods. Helsel and Hirsch (1992) outline the limitations of a two-sample t-test compared to the rank-sum test when applied to non-normal data.

For seasonal analysis and flow-adjusted analysis, the rank-sum test can be applied for step trends in the same way the seasonal Kendall test is applied for monotonic trends (Helsel and Hirsch, 1992). The seasonal rank-sum test separately computes the rank-sum statistic for each season, sums the test statistics, and then the summed test statistic is used to evaluate the overall step trend. The H-L estimator of step magnitude can be similarly modified. For seasonal analysis, the H-L estimator of trend magnitude is constructed by taking all differences within a given season, and finding the median of all of these values over all of the seasons. To perform flow-adjusted step-trend analysis, the residuals from OLS regression or LOWESS are input to the rank-sum test.

The rank-sum test can be applied to censored records, but the censoring must be at a single detection limit and should not exceed 50 percent of each group of data. The user has the option of censoring all the data at one reporting limit, but if there is a large number of data between detection limits, this may present a loss of information severe enough to obscure differences between groups. Helsel and Hirsch (1992, p. 369-370) discuss several alternative nonparametric methods for the rank-sum test and their limitations.

Step-trend procedures should never be applied based solely on examination of the data (without a prior hypothesis concerning dates and causes for such an occurrence) or on a computation of the time which maximizes differences between periods. The decision to perform step-trend analysis and where to split the record should be made prior to any examination of the data values. Splitting the record based on prior examination of the data biases the significance level of the test (Helsel and Hirsch, 1992), resulting in higher than expected (and unrealistic) probability values.

SUMMARY AND CONCLUSIONS

Methods for streamflow-estimation and trend analysis, along with associated data requirements and limitations, were discussed to aid the FDEP in establishing protocols for their SWAMP network. USGS continuous-record streamflow stations at or near SWAMP network stations were identified to assess the availability of streamflow data for SWAMP sites. Of the 315 SWAMP sites in the trend network, 71 sites are located at active USGS gaging stations, and 60 sites are located near active USGS gaging stations. The streamflow data can provide important information for evaluating changes in water-quality with flow and for assessing trends in water quality over time.

Several methods were described for estimating instantaneous or daily mean streamflow at SWAMP sites located near streamflow-gaging stations. The selection of an appropriate method depends on the availability of gaged data near the SWAMP site, the desired accuracy of the estimates, the range of flows of interest, the correlation between target flows at the gaged and ungaged sites, and the basin characteristics. Basic selection criteria are summarized in figure 5. The data requirements and restrictions for particular streamflow-estimation methods are summarized in table 6.

Streamflow estimation is limited by several factors. At sites where no measurements of streamflow have been made, the error of streamflow estimates is unknown. In addition, the error of the estimates is likely to vary for different flow magnitudes. Publications that focus on factors affecting streamflow, and ground-water/surface-water interactions provide some indication of the regional variations in factors potentially limiting application of streamflow-estimation techniques in specific areas of Florida. Additional information on the local hydrology and water use (regulation, diversions) is necessary for determining where flow-estimation methods can be applied.

Trend methods include both monotonic and step-trend tests that can be adjusted to account for seasonal cycles and, in the case of water-quality trends, to account for streamflow fluctuations. These tests are predominantly nonparametric, but include some parametric methods, all of which have been previously published. The methods can be applied to streamflow, water-quality, and flow-adjusted water-quality data.

The nonparametric methods avoid many of the shortcomings of parametric methods when applied to hydrologic data, particularly when skewed distributions and censored data are present. Removing variability due to streamflow and/or season can improve the likelihood of detecting existing trends in water-quality constituents and can aid in determining causes of the trends. The approach to trend analysis described in this report is well suited to analysis of multistation networks collecting data for multiple constituents at irregular intervals, such as the SWAMP network.

Data requirements are important components of any trend analysis, and are discussed in the report. For example, when data are missing or have been censored at one or more detection limits, special considerations apply, including both the types of tests that can be applied and the hypotheses that can be tested. When more than about 5 percent of the data in the record have been censored, and the Seasonal-Kendall procedure is used, flow-adjustment cannot be performed and slope estimates cannot be reliably obtained. Criteria for selecting trend methods for a particular application are summarized in figures 6 and 7. The requirements for each of the trend methods included in the report are summarized in table 7.

Review of trend results may give a false impression of the complexity of selecting and applying appropriate methods for trend analysis. Although summaries of trend results may appear simple and uncomplicated, the data records and analytical techniques selected for the analysis are critical components that need to be evaluated along with the trend results. Field and laboratory methods, sampling frequency, and environmental factors (such as changes in streamflow and land use), as well as the correct application of analytical techniques, can affect trend results and, in regional studies, the comparability of trends between sites.

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APPENDICES

Appendix A.—U.S. Geological Survey continuous-record streamflow-gaging stations active as of water year 1996

[Map ID corresponds to ID numbers shown on plate 2. USGS region codes denote the geographic area and the corresponding USGS office performing data collection. sq.mi., square miles; n.d., not determined (some drainage areas are indeterminate); NE, northeast (Orlando Subdistrict), NW, northwest (Tallahassee District), SW, southwest (Tampa Subdistrict), S, south (Miami Subdistrict); GA, Georgia (Doraville). Other abbreviations: LK, lake; BLVD, boulevard; CR, Creek; BCH, beach; FT, fort; CA, canal; AV, avenue. All sites are within Florida unless otherwise noted]

Map ID	Station number	Station name	Latitude	Longitude	Drainage area (sq mi)	Begin record (year)	USGS region code
1	02228500	NORTH PRONG ST MARYS RIVER AT MONIAC, GA	303103	821350	160.00	1921	NE
2	02229000	MIDDLE PRONG ST MARYS RI AT TAYLOR	302610	821715	125.00	1921	NE
6	02231000	ST MARYS RIVER NEAR MACCLENNY	302131	820454	700.00	1926	NE
8	02231268	ALLIGATOR CREEK AT CALLAHAN	303359	815001	14.00	1981	NE
9	02231280	THOMAS CREEK NEAR CRAWFORD	302739	814957	29.00	1965	NE
10	02231289	NASSAU RIVER NEAR HEDGES	303428	813632	274.00	1983	NE
11	0223129985	INTERCOASTAL WATERWAY NEAR CEDAR POINT	302742	812659	n.d.	1987	NE
12	02231342	FORT DRUM CR AT SUNSHINE ST PKY NEAR FT DRUM	273406	804747	52.00	1969	NE
15	02231396	BLUE CYPRESS CREEK NEAR FELLSMERE	274340	804819	n.d.	1996	NE
16	02231454	SIXMILE CREEK NEAR KENANSVILLE	275200	805140	n.d.	1995	NE
17	02231458	WOLF CREEK NEAR KENANSVILLE	275339	804917	n.d.	1996	NE
18	02231600	JANE GREEN CREEK NEAR DEER PARK	280427	805318	248.00	1953	NE
19	02232000	ST JOHNS RIVER NEAR MELBOURNE	280504	804508	968.00	1939	NE
20	02232200	WOLF CREEK NEAR DEER PARK	281246	805440	25.00	1956	NE
21	02232400	ST JOHNS RIVER NEAR COCOA	282210	805222	1331.00	1954	NE
22	02232500	ST JOHNS RIVER NEAR CHRISTMAS	283234	805637	1539.00	1934	NE
23	02233001	ECONLOCKHATCHEE RIVER AT MAGNOLIA RANCH NEAR BITHLO	282527	810710	32.00	1972	NE
25	02233200	LITTLE ECONLOCKHATCHEE RIVER NEAR UNION PARK	283129	811439	27.00	1960	NE
26	02233500	ECONLOCKHATCHEE RIVER N CHULUOTA	284040	810651	241.00	1936	NE
27	02234000	ST JOHNS RIVER ABOVE LAKE HARNEY NEAR GENEVA	284250	810208	2043.00	1941	NE
30	02234324	HOWELL CREEK NEAR SLAVIA	283851	811553	29.00	1972	NE
32	02234384	SOLDIER CREEK NEAR LONGWOOD	284307	811832	21.00	1972	NE
33	02234400	GEE CREEK NEAR LONGWOOD	284214	811727	12.00	1972	NE
34	02234635	WEKIVA RIVER NEAR APOPKA	284248	812644	n.d.	1996	NE
35	02234990	LITTLE WEKIVA RIVER NEAR ALTAMONTE SPRINGS	284113	812350	90.00	1972	NE
36	02234998	LITTLE WEKIVA RIVER NEAR LONGWOOD	284207	812332	n.d.	1996	NE
37	022349993	WEKIVA RIVER AT OLD RR CROSSING NEAR SANFORD	284733	812449	n.d.	1996	NE
38	02235000	WEKIVA RIVER NEAR SANFORD	284854	812510	189.00	1932	NE
39	02235200	BLACKWATER CREEK NEAR CASSIA	285228	812923	126.00	1962	NE
40	02235500	BLUE SPRINGS NEAR ORANGE CITY	285638	812024	n.d.	1932	NE
41	02236000	ST JOHNS RIVER NEAR DELAND	290029	812258	3066.00	1934	NE
42	02236120	DEEP CREEK NEAR BARBERVILLE	290947	812327	35.00	1965	NE
43	02236350	GREEN SWAMP RUN NEAR EVA	281839	814108	43.00	1979	NE
44	02236500	BIG CREEK NEAR CLERMONT	282651	814425	68.00	1958	NE
45	02236700	LITTLE CREEK NEAR CLERMONT	282739	814526	14.00	1979	NE
46	02236900	PALATLAKAHA RIVER AT CHERRY LK OUT NEAR GROVELAND	283533	814921	165.00	1956	NE
48	02237293	PALATLAKAHA RIVER AT STRUCT M-1 NEAR OKAHUMPKA	284439	815222	221.00	1970	NE
49	02237700	APOPKA-BEAUCLAIR CANAL NEAR ASTATULA	284320	814106	184.00	1942	NE
50	02238000	HAINES CREEK AT LISBON	285214	814702	648.00	1942	NE
51	02238500	OKLAWAHA RIVER AT MOSS BLUFF	290452	815251	879.00	1943	NE

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53	02239500	SILVER SPRINGS NEAR OCALA	291244	820315	n.d.	1947	NE
54	02240000	OKLAWAHA RIVER NEAR CONNER	291252	815910	1196.00	1930	NE
55	02240500	OKLAWAHA RIVER AT EUREKA	292218	815407	1367.00	1930	NE
56	02240902	PRAIRIE CREEK NEAR GAINESVILLE	293641	821456	114.00	1947	NE
57	02240954	HOGTOWN CREEK NEAR ARREDONDO	293817	822333	41.00	1972	NE
58	02241000	CAMPS CANAL NEAR ROCHELLE	293433	821500	775.00	1948	NE
61	02243000	ORANGE CREEK AT ORANGE SPRINGS	293034	815647	1119.00	1942	NE
63	02243960	OKLAWAHA RIVER AT RODMAN DAM NEAR ORANGE SPRINGS	293030	814815	2747.00	1969	NE
65	02244032	CROSSORIDA BARGE CA AT BUCKMAN LOCK NEAR PALATKA	293245	814335	n.d.	1970	NE
66	02244040	ST. JOHNS RIVER AT BUFFALO BLUFF NEAR SATSUMA	293546	814100	n.d.	1991	NE
67	02244320	MIDDLE HAW CREEK NEAR KORONA	292135	811842	78.00	1975	NE
68	02244420	LITTLE HAW CR NEAR SEVILLE	291920	812310	93.00	1951	NE
69	02244440	DUNNS CREEK NEAR SATSUMA	293439	813735	585.00	1978	NE
71	02244473	RICE CREEK NEAR SPRINGSIDE	294117	814432	43.00	1974	NE
72	02244601	SAND HILL LAKE OUTLET NEAR KEYSTONE HEIGHTS	295017	820034	n.d.	1994	NE
73	02244651	MAGNOLIA LAKE OUTLET NEAR KEYSTONE HEIGHTS	294902	820121	n.d.	1994	NE
74	02244690	ALLIGATOR CREEK NEAR KEYSTONE HEIGHTS	294832	820200	n.d.	1994	NE
76	02245140	SIMMS CREEK NEAR BARDIN	294407	814236	47.00	1973	NE
77	02245200	RICE CREEK NEAR PALATKA	294157	813948	n.d.	1996	NE
78	02245255	DEEP CREEK NEAR HASTINGS	294052	812656	20.00	1975	NE
79	02245260	DEEP CREEK AT SPUDS	294346	812913	n.d.	1993	NE
80	02245328	SIXMILE CREEK NEAR PICOLATA	295734	813237	n.d.	1994	NE
81	02245500	SOUTH FORK BLACK CREEK NEAR PENNEY FARMS	295845	815108	134.00	1940	NE
82	02246000	NORTH FORK BLACK CREEK NEAR MIDDLEBURG	300647	815424	177.00	1932	NE
84	02246150	BIG DAVIS CREEK AT BAYARD	300905	813135	13.00	1964	NE
86	02246300	ORTEGA RIVER AT JACKSONVILLE	301450	814749	30.00	1928	NE
89	02246500	ST JOHNS RIVER AT JACKSONVILLE	301913	813932	8850.00	1954	NE
94	02246828	PABLO CREEK AT JACKSONVILLE	301407	812842	25.00	1974	NE
100	02247480	TIGER BAY CANAL NEAR DAYTONA BCH	290958	810918	29.00	1978	NE
101	02247496	THAYER CANAL NEAR DAYTONA BCH	291043	810714	33.00	1982	NE
103	02247510	TOMOKA RIVER NEAR HOLLY HILL	291302	810632	76.00	1965	NE
104	02248000	SPRUCE CREEK NEAR SAMSULA	290301	810249	33.00	1951	NE
105	02248037	B-19 CANAL AT WILLOW RUN BLVD NEAR PORT ORANGE	290730	810145	n.d.	1989	NE
107	02248358	UNNAMED DRAINAGE DITCH NE SCOTTSMORE	284706	805118	n.d.	1996	NE
108	02248365	BIGOUNDER CK NEAR SCOTTSMOOR	284520	805100	n.d.	1996	NE
109	02248380	HAULOVER CANAL NEAR MIMS	284411	804517	n.d.	1996	NE
110	02248510	ADDISON CREEK NEAR TITUSVILLE	283220	804736	4.00	1989	NE
111	02249007	EAU GALLIE RIVER AT HEATHER GLEN CR AT MELBOURNE	280735	803849	3.00	1991	NE
112	02249020	EAU GALLIE RIVER AT US HWY 1 AT MELBOURNE	280726	803751	5.00	1987	NE
114	02249510	CRANE CREEK AT BABCOCK STREET AT MELBOURNE	280406	803717	15.00	1987	NE
115	02249515	HICKORY STREET DRAINAGE CANAL AT MELBOURNE	280417	803648	n.d.	1987	NE
116	02249518	CANE CREEK AT U.S. HIGHWAY 1 AT MELBOURNE	280437	803609	18.00	1987	NE
121	02250030	TURKEY CREEK AT PALM BAY	280100	803546	105.00	1981	NE
122	02250500	GOAT CREEK NEAR VALKARIA	275801	803357	12.00	1989	NE
123	02250700	TROUT CREEK AT GRANT	275613	803207	15.00	1989	NE
124	02251210	SOUTH PRONG SEBASTIAN CREEK AT ROSELAND	274956	803001	63.00	1987	NE

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125	02251500	NORTH PRONG SEBASTIAN CREEK NEAR MICCOSUKEE	275121	803128	28.00	1955	NE
127	02251767	FELLSMERE CANAL NEAR MICCOSUKEE	274949	803204	n.d.	1991	NE
128	02252500	NORTH CANAL NEAR VERO BEACH	274132	802500	n.d.	1951	NE
129	02253000	MAIN CANAL AT VERO BEACH	273854	802410	n.d.	1949	NE
130	02253500	SOUTH CANAL NEAR VERO BEACH	273611	802324	n.d.	1951	NE
132	02256500	FISHEATING CREEK AT PALMDALE	265556	811854	311.00	1931	NE
137	02262900	BOGGY CREEK NEAR TAFT	282216	811839	83.00	1959	NE
139	02263800	SHINGLE CREEK AT AIRPORT NEAR KISSIMMEE	281814	812704	89.00	1959	NE
140	02263869	SOUTH LAKE OUTLET AB S-15 NEAR VINELAND	282445	813217	4.00	1972	NE
141	02264000	CYPRESS CREEK AT VINELAND	282325	813111	30.00	1945	NE
142	02264051	BLACK LAKE OUTLET AT S-101A AT BUENA VISTA	282228	813101	n.d.	1987	NE
143	02264060	LATERAL 101 AT S-101 NEAR BUENA VISTA	282215	813145	n.d.	1987	NE
144	02264100	BONNET CREEK NEAR VINELAND	281958	813120	56.00	1943	NE
145	02264495	SHINGLE CREEK AT CAMPBELL	281601	812653	180.00	1969	NE
148	02266025	REEDY CREEK AB S-46 NEAR VINELAND	282418	813642	20.00	1969	NE
149	02266200	WHITTENHORSE CREEK NEAR VINELAND	282305	813700	12.00	1966	NE
150	02266205	WHITTENHORSE CREEK AT S-411 NEAR VINELAND	282334	813640	13.00	1987	NE
151	02266291	LATERAL-405 AB S-405A NEAR DOCTOR PHILLIPS	282537	813619	10.00	1969	NE
152	02266295	10B LATERAL 410 AT S-410 NEAR VINELAND	282128	813556	n.d.	1987	NE
153	02266300	REEDY CREEK NEAR VINELAND	281957	813448	75.00	1960	NE
154	02266480	DAVENPORT CREEK NEAR LOUGHMAN	281615	813528	23.00	1969	NE
155	02266500	REEDY CREEK NEAR LOUGHMAN	281548	813212	110.00	1940	NE
156	02266550	REEDY CREEK AT STATE HIGHWAY 531	280859	812628	170.00	1979	NE
157	02267000	CATFISH CREEK NEAR LAKE WALES	275740	812948	58.00	1948	NE
159	02268390	TIGER CREEK NEAR BABSON PARK	274840	812638	52.80	1991	SW
160	02268903	KISSIMMEE RIVER AT S-65 NEAR LAKE WALES	274814	811153	1607.00	1970	NE
161	02268904	KISSIMMEE RIVER BELOW S-65 NEAR LAKE WALES	274814	811153	1607.00	1970	NE
164	02269520	LIVINGSTON CREEK NEAR FROSTPROOF	274230	812648	120.00	1991	SW
165	02270000	CARTER CREEK NEAR SEBRING	273155	812316	38.80	1955	SW
166	02270500	ARBUCKLE CREEK NEAR DE SOTO CITY	272632	811751	379.00	1939	NE
168	02271500	JOSEPHINE CREEK NEAR DESOTO CITY	272226	812337	109.00	1946	SW
169	02271990	ISTOKPOGA CREEK NEAR CORNWELL	272402	810959	n.d.	1995	NE
172	02272678	CHANDLER SLOUGH NEAR BASINGER	272241	805914	n.d.	1995	NE
173	02273000	KISSIMMEE RIVER AT S-65E NEAR OKEECHOBEE	271332	805746	n.d.	1929	NE
179	02275503	TAYLOR CREEK AT HGS-6 NEAR OKEECHOBEE	271235	804756	n.d.	1996	NE
180	02275705	HENRY CREEK AT HENRY CK LOCK NEAR SHERMAN	270943	804304	n.d.	1993	NE
181	02276870	ST LUCIE CANAL AT LAKE OKEECHOBEE	265900	803700	n.d.	1931	S
183	02277000	ST LUCIE CA AT LOCK NEAR STUART	270639	801706	n.d.	1953	S
184	02277600	LOXAHATCHEE RIVER NEAR JUPITER	265620	801030	n.d.	1971	S
187	02278000	WEST PALM BEACH CANAL AT S352 AT CANAL POINT	265105	803755	n.d.	1940	S
188	02278450	WEST PALM BEACH CANAL ABOVE S-5A NEAR LOXAHATCHEE	264105	802215	n.d.	1958	S
189	02278500	DIV TO CONS AREA AT S-5A NEAR LOXAHATCHEE	264100	802210	n.d.	1958	S
190	02278550	LEVEE 8 CA AT W PALM BCH CA NEAR LOXAHATCHE	264105	802135	n.d.	1958	S
191	02278600	WEST PALM BEACH CA BL S-5A-E NEAR LOXAHATCH	264105	802150	n.d.	1955	S
192	02279000	WEST PALM BEACH CANAL AT WEST PALM BEACH	263840	800322	n.d.	1940	S
193	02280500	HILLSBORO CANAL BELOW S351 NEAR SOUTH BAY	264200	804245	n.d.	1957	S

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194	02281200	HILLSBORO CANAL AT S-6	262818	802646	146.00	1958	S
196	02281400	HILLSBORO CANAL NEAR MARGATE	261948	801245	n.d.	1976	S
201	02282700	MIDDLE RIVER CANAL AT S-36 NEAR FT LAUDERDALE	261022	801047	n.d.	1962	S
202	02283200	PLANTATION RD CA AT S-33 NEAR FT LAUDERDALE	260805	801142	n.d.	1962	S
203	02283498	N NEW RIVER CA AT S-2 AND S351 NEAR SOUTH BAY	264200	804255	n.d.	1968	S
204	02283500	N NEW RIVER CANAL BELOW S351 NEAR SOUTH BAY	264150	804250	n.d.	1957	S
205	02284300	NORTH NEW RIVER CANAL AT S-7 AT TERRYTOWN	262007	803214	n.d.	1960	S
209	02286100	SOUTH NEW RIVER CANAL AT S-13 NEAR DAVIE	260357	801232	n.d.	1957	S
211	02286200	SNAKE CREEK CANAL AT NW67 AVE NEAR HIALEAH	255750	801840	n.d.	1962	S
215	02286400	MIAMI CANAL AT HGS-3 AND S-3 AT LAKE HARBOR	264155	804825	n.d.	1940	S
216	02286700	MIAMI CA AT S8 NEAR LAKE HARBOR	261953	804629	n.d.	1962	S
218	02287395	MIAMI CANAL EAST OF LEVEE 30 NEAR MIAMI	255628	802623	n.d.	1960	S
220	02287497	N.W. WELLFIELD CANAL NEAR DADE BROWARD LEVE	255328	802613	n.d.	1991	S
222	02288010	N.W. WELLFIELD CANAL NEAR PENNSUCO	255234	802317	n.d.	1991	S
225	02288600	MIAMI CANAL AT NW36 ST MIAMI	254829	801549	n.d.	1959	S
226	02288800	TAMIAMI CANAL OUTLETS MONROE TO CARNESTOW	255310	811530	n.d.	1960	S
227	02288900	TAMIAMI CANAL OUTLETS 40-MILE BEND TO MONROE	255105	805850	n.d.	1940	S
229	02289019	TAMIAMI CANAL BELOW S-12-B NEAR MIAMI	254540	804605	n.d.	1963	S
230	02289027	DRAINAGE CANAL BELOW G,136 NEAR CLEWISTON	264002	805618	n.d.	1993	S
232	02289031	LEVEE 3 CANAL BELOW G,155 NEAR CLEWISTON	261948	805248	n.d.	1993	S
233	02289032	LEVEE 4 CANAL BELOW G-88 NEAR CLEWISTON	261952	805248	n.d.	1993	S
234	02289040	TAMIAMI CANAL OUTLETS L67A TO 40 MI BEND NEAR MIAMI	S254522	804334	n.d.	1940	S
235	02289041	TAMIAMI CANAL BELOW S-12-C NEAR MIAMI	254540	804334	n.d.	1963	S
236	02289050	TAMIAMI CANAL ABOVE S-333 NEAR MIAMI	254539	804027	n.d.	1982	S
237	02289060	TAMIAMI CANAL OUTLETS L-30 TO L-67A NEAR MIAMI	254540	803340	n.d.	1940	S
238	02289096	N.W. WELLFIELD CANAL AT CONS AREA NO. 3	255531	802717	n.d.	1991	S
239	02289500	TAMIAMI CANAL NEAR CORAL GABLES	254543	801942	n.d.	1940	S
246	02290710	BLACK CREEK CANAL AT S-21 NEAR GOULDS	253234	801952	n.d.	1971	S
248	022907647	LEVEE 31 NORTH EXTENSION AT 1 MILE	254454	802952	n.d.	1992	S
249	02290765	LEVEE 31 NORTH EXTENSION AT 3 MILE	254447	802952	n.d.	1992	S
250	02290766	LEVEE 31 NORTH EXTENSION AT 4 MILE	254206	802946	n.d.	1994	S
251	02290767	LEVEE 31 NORTH EXTENSION AT 5 MILE	254109	802950	n.d.	1994	S
252	02290768	LEVEE 31 NORTH EXTENSION AT 7 MILE	253947	802954	n.d.	1994	S
253	02290769	CANAL 111 ABOVE S-18-C NEAR FLORIDA CITY	251949	803131	n.d.	1969	S
258	02291000	BARRON RIVER NEAR EVERGLADES	255728	812119	n.d.	1951	S
263	02291500	IMPERIAL RIVER NEAR BONITA SPRINGS	262007	814459	65.00	1987	S
264	02291524	SPRING CREEK HEADWATER NEAR BONITA SPRING	262142	814727	n.d.	1988	S
265	02291580	NORTH BRANCH ESTERO RIVER AT ESTERO	262630	814745	22.00	1987	S
266	02291597	SOUTH BRANCH ESTERO RIVER AT ESTERO	262543	814736	25.00	1987	S
267	02291650	WHISKEY CREEK AT WHISKEY CREEK CLUB	263427	815329	n.d.	1994	S
268	02291669	SIXMILE CYPRESS CREEK NORTH NEAR FORT MYERS	263120	815117	n.d.	1988	S
269	02291673	TENMILE CANAL AT CONTROL NEAR ESTERO	263104	815118	n.d.	1988	S
270	02292000	CALOOSAHATCHEE CA AT MOORE HAVEN	265022	810515	n.d.	1913	S
271	02292480	CALOOSAHATCHEE CAN AT ORTONA LOCK	264722	811811	n.d.	1949	S
272	02292780	TOWNSEND CANAL NEAR ALVA	264233	813330	n.d.	1976	S
273	02292900	CALOOSAHATCHEE RIVER AT S-79 NEAR OLGA	264325	814155	n.d.	1966	S

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275	02293214	MEADE CANAL AT CAPE CORAL	263810	815550	n.d.	1987	S
276	02293216	MACKINAC CANAL AT CAPE CORAL	263809	815729	n.d.	1987	S
277	02293240	ARIES CANAL AT CAPE CORAL	263601	815948	n.d.	1990	S
278	02293241	SAN CARLOS CANAL AT CAPE CORAL	263611	815754	n.d.	1987	S
279	02293243	COURTNEY CANAL AT CAPE CORAL	263439	815908	n.d.	1987	S
280	02293345	SHADROE CANAL AT CAPE CORAL	263905	820210	n.d.	1987	S
282	02293347	HERMOSA CANAL AT CAPE CORAL	264008	820218	n.d.	1987	S
285	02293987	PEACE CREEK DRAINAGE CANAL NEAR WAHNETA	275528	814337	162.00	1991	SW
287	02294491	SADDLE CREEK AT STRUCT P-11 NEAR BARTOW	275617	815105	135.00	1964	SW
288	02294650	PEACE RIVER AT BARTOW	275407	814903	390.00	1940	SW
289	02294781	PEACE RIVER NEAR HOMELAND	274915	814759	437.00	1981	SW
290	02294898	PEACE RIVER AT FORT MEADE	274504	814656	480.00	1974	SW
291	02295013	BOWLEGS CREEK NEAR FT MEADE	274159	814144	47.20	1991	SW
292	02295420	PAYNE CREEK NEAR BOWLING GREEN	273713	814933	121.00	1964	SW
293	02295637	PEACE RIVER AT ZOLFO SPRINGS	273015	814804	828.00	1933	SW
295	02296500	CHARLIE CREEK NEAR GARDNER	272229	814748	330.00	1950	SW
296	02296750	PEACE RIVER AT ARCADIA	271319	815234	1367.00	1931	SW
297	02297100	JOSHUA CREEK AT NOCATEE	270959	815247	132.00	1950	SW
298	02297155	HORSE CREEK NEAR MYAKKA HEAD	272913	820125	120.00	1978	SW
299	02297310	HORSE CREEK NEAR ARCADIA	271157	815919	218.00	1950	SW
300	02298123	PRAIRE CREEK NEAR FT OGDEN	270306	814705	162.00	1964	SW
305	02298830	MYAKKA RIVER NEAR SARASOTA	271425	821850	229.00	1936	SW
307	02299060	DEER PRAIRIE SLOUGH NEAR MYAKKA CITY	271033	821242	n.d.	1993	SW
308	02299160	DEER PRAIRIE SLOUGH NEAR NORTH PORT CHARLOTTE	270651	821550	33.20	1981	SW
309	02299410	BIG SLOUGH CANAL NEAR MYAKKA CITY	271135	820840	36.50	1980	SW
310	02299455	BIG SLOUGH CANAL AT N PORT CHARLOTTE	270630	821220	86.00	1989	SW
312	02299780	PHILLIPPE CREEK NEAR BEE RIDGE	271922	822853	31.10	1994	SW
313	02299861	WALKER CREEK NEAR SARASOTA	272203	823240	4.91	1991	SW
314	02299950	MANATEE RIVER NEAR MYAKKA HEAD	272824	821241	65.00	1966	SW
316	02300005.0	WILLIAMS CREEK NEAR BRADENTON	272710	822804	2.70	1994	SW
317	02300032	BRADEN RIVER NEAR LORRAINE	272520	822500	25.80	1988	SW
318	02300034	HICKORY HAMMOCK CREEK NEAR LORRAINE	272518	822556	2.40	1988	SW
319	02300035.5	COOPER CR AT UNIVERSITY PARKWAY NEAR SARASOTA	272318	822735	9.33	1988	SW
320	02300037	CEDAR CREEK NEAR SARASOTA	272451	822853	0.94	1988	SW
321	02300038	RATTLESNAKE SLOUGH NEAR SARASOTA	272524	822925	3.78	1988	SW
322	02300039	NONSENSE CREEK NEAR BRADENTON	272604	822804	1.14	1988	SW
323	02300042	WARD LAKE OUTFALL NEAR BRADENTON	272617	822913	59.50	1992	SW
324	02300056	GAP CREEK NEAR BRADENTON	272642	823057	7.20	1995	SW
325	02300062	GLEN CREEK NEAR BRADENTON	272844	823148	2.50	1995	SW
326	02300100	LITTLE MANATEE RIVER NEAR FT LONESOME	274216	821153	31.00	1963	SW
327	02300500	LITTLE MANATEE RIVER NEAR WIMAUMA	274015	822110	149.00	1939	SW
329	02300700	BULLFROG CREEK NEAR WIMAUMA	274730	822108	29.00	1957	SW
330	02301000	NORTH PRONG ALAFIA RIVER AT KEYSVILLE	275259	820603	135.00	1950	SW
331	02301300	SOUTH PRONG ALAFIA RIVER NEAR LITHIA	274747	820704	107.00	1963	SW
333	02301500	ALAFIA RIVER AT LITHIA	275219	821241	335.00	1933	SW
334	02301600	LITHIA SPRINGS NEAR LITHIA	275200	821350	n.d.	1956	SW

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336	02301750	DELANEY CREEK NEAR TAMPA	275532	822152	16.00	1985	SW
339	02301900	FOX BRANCH NEAR SOCRUM	281055	820045	9.00	1964	NE
340	02301990	HILLSB RIVER AB CRYSTAL SPRINGS NEAR ZEPHYRHILLS	281107	821103	82.00	1984	SW
341	02302000	CRYSTAL SPRINGS NEAR ZEPHYRHILLS	281030	821120	n.d.	1935	SW
342	02302500	BLACKWATER CREEK NEAR KNIGHTS	280825	820900	110.00	1951	SW
343	02303000	HILLSBOROUGH RIVER NEAR ZEPHYRHILLS	280859	821357	220.00	1940	SW
345	02303205	BAKER CR AT MACINTOSH RD NEAR ANTIOCH	280141	821444	27.40	1992	SW
347	02303330	HILLSBOROUGH RIVER AT MORRIS BR NEAR THONOTOSASSA	280550	821845	375.00	1972	SW
348	02303350	TROUT CREEK NEAR SULPHUR SPRINGS	280820	822150	23.00	1962	SW
349	02303352	TROUT CREEK NEAR TEMPLE TERRACE	280552	822130	31.00	1980	SW
350	02303400	CYPRESS CREEK NEAR SAN ANTONIO	281925	822303	56.00	1963	SW
351	02303420	CYPRESS CREEK AT WORTHINGTON GARDENS	281108	822403	117.00	1964	SW
353	02303800	CYPRESS CREEK NEAR SULPHUR SPRINGS	280520	822433	160.00	1956	SW
354	02304000	HILLSBOROUGH RIVER AT FOWLER AVE NEAR TEMPLE TERRACE	280315	822150	630.00	1934	SW
355	02304500	HILLSBOROUGH RIVER NEAR TAMPA	280125	822540	650.00	1939	SW
359	02306000	SULPHER SPRINGS AT SULPHER SPRINGS	280115	822707	n.d.	1959	SW
361	02306500	SWEETWATER CREEK NEAR SULPHUR SPRINGS	280235	823042	7.00	1952	SW
362	02306647	SWEETWATER CREEK NEAR TAMPA	280049	823243	14.00	1985	SW
363	02306654	HENRY ST CANAL NEAR TAMPA	275959	823305	n.d.	1985	SW
364	02306774	ROCKY CREEK AT ST HWY 587 AT CITRUS PARK	280355	823400	17.00	1986	SW
366	02306950	BRUSHY CREEK NEAR CITRUS PARK	280353	823320	17.00	1993	SW
367	02307000	ROCKY CREEK NEAR SULPHUR SPRINGS	280212	823434	35.00	1953	SW
368	02307200	BROOKER CREEK AT VAN DYKE RD NEAR CITRUS PARK	280734	823414	5.00	1981	SW
371	02307359	BROOKER CREEK NEAR TARPON SPRINGS	280545	824115	30.00	1950	SW
373	02307668	ALLIGATOR CREEK BELOW BELCHER RD AT CLEAR	275846	824433	3.67	1996	SW
379	02309848	SOUTH BRANCH ANCLOTE RIVER NEAR ODESSA	281108	823313	17.00	1970	SW
381	02310000	ANCLOTE RIVER NEAR ELFERS	281250	824000	72.00	1946	SW
382	02310147	HOLLIN CREEK NEAR TARPON SPRINGS	280944	824238	4.00	1981	SW
384	02310280	PITHLACHASCOTEE RIVER NEAR FIVAY JUNCTION	281944	823213	150.00	1964	SW
385	02310300	PITHLACHASCOTEE RIVER NEAR NEW PORT RICHEY	281523	823833	182.00	1963	SW
388	02310500	WEEKI WACHEE SPRING NEAR BROOKSVILLE	283100	823425	n.d.	1995	SW
389	02310678	HOMOSASSA SPRINGS AT HOMOSASSA SPRINGS	284758	823520	n.d.	1995	SW
392	02310947	WITHLACOOCHEE RIVER NEAR CUMPRESSCO	281842	820322	280.00	1967	NE
393	02311000	WITHLACOOCHE-HILLSBOROUGH OV NEAR RICHLAND	281616	820553	n.d.	1930	NE
394	02311500	WITHLACOOCHEE RIVER NEAR DADE CITY	282108	820734	390.00	1930	NE
395	02311700	DADE CITY CANAL NEAR DADE CITY	282255	821048	35.00	1957	NE
396	02312000	WITHLACOOCHEE RIVER AT TRILBY	282847	821040	570.00	1928	NE
397	02312140	BAYROOT SLOUGH HEADWATERS NEAR BAY LAKE	282723	815514	18.00	1960	NE
398	02312180	LITTLE WITHLACOOCHEE RIVER NEAR TARRYTOWN	283117	820318	85.00	1967	NE
401	02312200	LITTLE WITHLACOOCHEE RIVER AT RERDELL	283421	820920	145.00	1958	NE
402	02312500	WITHLACOOCHEE RIVER AT CROOM	283533	821320	810.00	1940	NE
403	02312600	WITHLACOOCHEE RIVER NEAR FLORAL CITY	284436	821313	995.00	1959	NE
405	02312640	JUMPER CREEK CANAL NEAR BUSHNELL	284145	820634	40.00	1963	NE
407	02312667	SHADY BROOK NEAR SUMTERVILLE	284612	820350	8.00	1932	NE
409	02312700	OUTLET RIVER AT PANACOOCHEE RETREATS	284901	820840	420.00	1963	NE
410	02312720	WITHLACOOCHEE RIVER AT WYSONG DAM AT CARLSON	284923	821100	1520.00	1965	NE

Map ID	Station number	Station name	Latitude	Longitude	Drainage area (sq mi)	Begin record (year)	USGS region code
412	02312975	TSALA APOKA OUTFALL CANAL AT S-353	285719	822013	n.d.	1968	NE
413	02313000	WITHLACOOCHEE RIVER NEAR HOLDER	285919	822059	1825.00	1928	NE
414	02313230	WITHLACOOCHEE RIVER AT INGLIS DAM NEAR DUNNELLON	290035	823701	2020.00	1964	NE
416	02313250	WITHLACOOCHEE RIVER BYPASS CHANNEL NEAR INGLIS	290115	823817	n.d.	1970	NE
418	02313700	WACCASASSA RIVER NEAR GULF HAMMOCK	291214	824609	480.00	1963	NW
422	02315000	SUWANNEE RIVER NEAR BENTON	303026	824259	2090.00	1976	NW
424	02315200	DEEP CREEK NEAR SUWANNEE VALLEY	302155	823713	88.00	1976	NW
426	02315500	SUWANNEE RIVER AT WHITE SPRINGS	301932	824418	2430.00	1906	NW
428	02315550	SUWANNEE RIVER AT SUWANNEE SPRINGS	302334	825600	2630.00	1975	NW
430	02319000	WITHLACOOCHEE RIVER NEAR PINETTA	303543	831535	2120.00	1932	NW
431	02319500	SUWANNEE RIVER AT ELLAVILLE	302304	831019	6970.00	1927	NW
433	02320500	SUWANNEE RIVER AT BRANFORD	295720	825540	7880.00	1931	NW
434	02320700	SANTA FE RIVER NEAR GRAHAM	295046	821311	94.90	1957	NW
435	02321000	NEW RIVER NEAR LAKE BUTLER	295953	821627	193.00	1950	NW
436	02321500	SANTA FE RIVER AT WORTHINGTON SPRINGS	295518	822535	575.00	1932	NW
437	02321900	PARENERS BRANCH NEAR BLAND	295426	823207	4.50	1993	NW
438	02321975	SANTA FE RIVER AT US441 NEAR HIGH SPRINGS	295109	823631	859.00	1994	NW
441	02322500	SANTA FE RIVER NEAR FORT WHITE	295055	824255	1017.00	1928	NW
442	02322616	CANNON CREEK NEAR LAKE CITY	300930	824002	2.33	1993	NW
444	02323500	SUWANNEE RIVER NEAR WILCOX	293522	825612	9640.00	1931	NW
445	02324000	STEINHATCHEE RIVER NEAR CROSS CITY	294711	831918	350.00	1950	NW
446	02324400	FENHOLLOWAY RIVER NEAR FOLEY	300553	832819	60.00	1955	NW
448	02325000	FENHOLLOWAY RIVER NEAR PERRY	300416	833945	160.00	1946	NW
449	02326000	ECONFINA RIVER NEAR PERRY	301014	834926	198.00	1950	NW
451	02326512	AUCILLA RIVER NEAR SCANLON	301352	835508	805.00	1950	NW
453	02327100	SOPCHOPPY RIVER NEAR SOPCHOPPY	300745	842940	102.00	1964	NW
454	02329000	OCHLOCKONEE RIVER NEAR HAVANA	303314	842303	1140.00	1926	NW
461	02329600	LITTLE RIVER NEAR MIDWAY	303044	843125	305.00	1965	NW
463	02330000	OCHLOCKONEE RIVER NEAR BLOXHAM	302310	843859	1700.00	1926	NW
464	02330100	TELOGIA CREEK NEAR BRISTOL	302535	845540	126.00	1950	NW
466	02358000	APALACHICOLA RIVER AT CHATTAHOOCHEE	304203	845133S	17200.00	1928	NW
468	02358700	APALACHICOLA RIVER NEAR BLOUNTSTOWN	302530	850153	17600.00	1920	NW
469	02358754	APALACHICOLA RIVER SAB CHIPOLA CUTOFF	300802	850839	17800.00	1950	NW
470	02359000	CHIPOLA RIVER NEAR ALTHA	303202	850955	781.00	1913	NW
471	02359170	APALACHICOLA RIVER NEAR SUMATRA	295657	850056	19200.00	1977	NW
473	02359500	ECONFINA CREEK NEAR BENNETT	302304	853324	122.00	1936	NW
475	02365500	CHOCTAWHATCHEE RIVER AT CARYVILLE	304632	854940	3499.00	1929	NW
477	02366500	CHOCTAWHATCHEE RIVER NEAR BRUCE	302703	855354	4384.00	1931	NW
478	02366900	MAGNOLIA CREEK NEAR FREEPORT	303148	860515	11.00	1968	NW
485	02369000	SHOAL RIVER NEAR CRESTVIEW	304150	863415	474.00	1938	NW
491	02375500	ESCAMBIA RIVER NEAR CENTURY	305754	871403	3817.00	1935	NW
495	02376115	ELEVENMILE CREEK NEAR WEST PENSACOLA	302953	872009	27.00	1988	NW
497	02376500	PERDIDO RIVER AT BARRINEAU PARK	304125	872625	394.00	1941	NW
498	252523080352500	LEVEE 31 W CANAL AT S332 NEAR FLORIDA CITY	252523	803525	n.d.	1983	S
499	254543080405401	TAMIAMI CANAL BELOW S12D NEAR MIAMI	254543	804054	n.d.	1963	S
500	254543080491101	TAMIAMI CANAL BELOW S12A NEAR MIAMI	254543	804911	n.d.	1963	S

Map ID	Station number	Station name	Latitude	Longitude	Drainage area (sq mi)	Begin record (year)	USGS region code
502	262007080321500	S-150 AT TERRYTOWN	262007	803215	n.d.	1991	S
503	264139082022100	GATOR SLOUGH AT SR 765 NEAR FT MYERS	264139	820201	n.d.	1984	S
504	264437081550100	GATOR SLOUGH AT US 41 NEAR FT MYERS	264437	815501	n.d.	1984	S
505	264514080550700	INDUSTRIAL CANAL AT CLEWISTON	264514	805507	n.d.	1982	S
506	265501080364900	LEVEE 8 CANAL NEAR CANAL POINT	265501	803649	n.d.	1976	S
507	270022080094600	KITCHINGS CREEK NEAR HOBE SOUND	270022	800946	n.d.	1984	S
508	270250082141600	WCS 101 NEAR NORTH PORT CHARLOTTE	270250	821416	n.d.	1994	SW
509	270435082063000	WCS 157 NEAR NORTH PORT CHARLOTTE	270435	820630	n.d.	1994	SW
510	270722082203400	MABRY CARLTON UNNAMED TRIBUTARY AT GUARDHOUSE	270722	822034	n.d.	1995	SW
511	270914082213700	WINDOM SLOUGH NEAR NORTH PORT CHARLOTTE	270914	822137	n.d.	1995	SW
512	274319081452000	ESTECH CLAY SETTLING POND OUTFLOW	274319	814520	n.d.	1995	SW
513	274906081594500	ACHAN CLAY SETTLING POND OUTFLOW	274906	815945	n.d.	1995	SW
514	280130082375500	DOUBLE BRANCH NEAR OLDSMAR	280130	823755	n.d.	1995	SW
515	02329342	LITTLE ATTAPULGUS CR AT ATTAPULGUS, GA	304408	842949	16.90	1991	GA
516	02343801	CHATTAHOOCHEE RIVER NEAR COLUMBIA, ALA	311533	850637	8210.00	1975	GA/AL

Appendix B.—U.S. Geological Survey continuous-record streamflow-gaging stations inactive as of water year 1996

[Map ID corresponds to ID numbers shown on plate 2. USGS region codes denote the geographic area and the corresponding USGS office performing data collection. sq.mi., square miles; n.d., not determined (some drainage areas are indeterminate); NE, northeast (Orlando Subdistrict), NW, northwest (Tallahassee District), SW, southwest (Tampa Subdistrict), S, south (Miami Subdistrict). Other abbreviations: LK, lake; BLVD, boulevard; CR, Creek; BCH, beach; FT, fort; CA, canal; AV, avenue. All sites are within Florida unless otherwise noted. All stations have 5 or more years of record]

Map ID	Station number	Station name	Latitude	Longitude	Drainage area (sq mi)	Period of record		USGS region code
						Start	End	
3	02229500	SOUTH PRONG ST MARYS RIVER NEAR SANDERSON	301217	821549	57.00	1955	1960	NE
4	02230000	TURKEY CREEK AT MACCLENNY	301608	820721	19.00	1955	1977	NE
5	02230500	SOUTH PRONG ST MARYS RIVER AT GLEN ST MARY	301640	820840	156.00	1950	1971	NE
7	02231253	ST MARYS RIVER NEAR GROSS	304429	814117	1360.00	1966	1989	NE
13	02231350	ST JOHNS HEADWATERS NEAR VERO BEACH	273826	804043	297.00	1942	1993	NE
14	02231390	COW LOG BRANCH NEAR YEEHAW JUNCTION	274119	805252	20.00	1982	1995	NE
24	02233102	ECONLOCKHATCHEE TRIBUTARY NEAR BITHLO	283355	811119	0.01	1976	1989	NE
28	02234100	DEEP CREEK NEAR OSTEEN	285045	810446	140.00	1965	1992	NE
29	02234180	DEEP CREEK DIVERSION CANAL NEAR OSTEEN	285044	810606	70.00	1935	1956	NE
31	02234365	SOLDIER CREEK HEADWATERS AT LAKE MARY	284457	812009	7.00	1988	1993	NE
47	02237000	PALATLAKAHA RIVER NEAR MASCOTTE	283656	815153	182.00	1945	1995	NE
52	02239000	OKLAWAHA RIVER NEAR OCALA	291100	815940	1018.00	1930	1968	NE
59	02242451	ORANGE LAKE OUTLET NEAR CITRA	292630	820633	1012.00	1941	1995	NE
60	02242500	LOCHLOOSA SLOUGH NEAR LOCHLOOSA	292917	820607	n.d.	1947	1992	NE
62	02243500	OKLAWAHA RIVER NEAR ORANGE SPRINGS	293013	815443	2657.00	1930	1952	NE
64	02244000	OKLAWAHA R AT RIVERSIDE L NEAR ORANGE SPRINGS	293000	814800	2747.00	1944	1968	NE
70	02244450	ST JOHNS RIVER AT PALATKA	293546	813629	7094.00	1968	1982	NE
75	02245050	ETONIA CREEK AT BARDIN	294300	814331	219.00	1974	1990	NE
83	02246025	BLACK CREEK NEAR DOCTORS INLET	300457	814843	403.00	1981	1995	NE
85	02246200	DURBIN CREEK NEAR DURBIN	300557	813134	36.00	1961	1994	NE
87	02246359	CEDAR RIVER AT MARIETTA	301850	814513	8.00	1990	1994	NE
88	02246460	WILLIAMSON CREEK AT CEDAR HILLS	301619	814505	n.d.	1971	1986	NE
90	02246515	POTTSBURG CREEK NEAR SOUTH JACKSONVILLE	301550	813525	9.00	1964	1994	NE
91	02246520	STRAWBERRY CREEK NEAR ARLINGTON	301926	813400	2.00	1990	1994	NE
92	02246522	RED BAY BRANCH TRIBUTARY AT JACKSONVILLE	302040	813522	n.d.	1975	1986	NE
93	02246650	SIXMILE CREEK NEAR MARIETTA	302214	814447	16.00	1989	1994	NE
95	02246832	CEDAR SWAMP CREEK NEAR JACKSONVILLE	301439	812826	3.00	1974	1992	NE
96	02246835	SANDALWOOD CANAL NEAR JACKSONVILLE BEACH	301822	812732	11.00	1990	1994	NE
97	02246850	DIEGO PLAINS SWAMP DRAIN AT MICKLER LANDING	300932	812137	4.00	1984	1989	NE
98	02246900	MOULTRIE CREEK AT SHWY 207 NEAR ST AUGUSTINE	295050	812139	19.00	1962	1992	NE
99	02247000	MOULTIRE CREEK NEAR ST AUGUSTINE	294940	812057	20.00	1940	1964	NE
102	02247508	ELEVENTH ST CANAL NEAR HOLLY HILL	291304	810632	3.00	1983	1992	NE
106	02248040	B-19 CANAL AT SR415 AT PORT ORANGE	290654	810128	7.00	1983	1992	NE
113	02249500	CRANE CREEK AT MELBOURNE	280442	803748	12.00	1951	1968	NE
117	02249950	C-1 CANAL NEAR RED BUD CIRCLE AT PALM BAY	280047	804330	n.d.	1988	1992	NE
118	02249970	C-10 CANAL AT MALABAR ROAD AT PALM BAY	275956	804247	n.d.	1988	1992	NE
119	02249990	C-69 CANAL AT PALM BAY ROAD AT PALM BAY	280206	804017	n.d.	1988	1992	NE
120	02250000	TURKEY CREEK NEAR PALM BAY	280046	803720	95.00	1956	1968	NE
126	02251765	FELLSMERE CANAL NEAR FELLSMERE	274918	803627	78.00	1955	1968	NE

Map ID	Station number	Station name	Latitude	Longitude	Drainage area (sq mi)	Period of record		USGS region code
						Start	End	
131	02256000	FISHEATING CREEK NEAR VENUS	270343	812538	188.00	1955	1966	NE
133	02257800	HARNEY POND CANAL AT S-71 NEAR LAKEPORT	270200	810415	n.d.	1963	1989	NE
134	02259200	INDIAN PRAIRIE CANAL AT S-72 NEAR OKEECHOBEE	270535	810025	n.d.	1963	1989	NE
135	02259500	INDIAN PRAIRIE CANAL NEAR OKEECHOBEE	270357	805912	n.d.	1939	1950	NE
136	02261500	MYRTLE-MARY JANE CANAL NEAR NARCOOSSEE	282022	811027	111.00	1950	1968	NE
138	02263500	ST CLOUD CANAL AT S-59 NEAR ST CLOUD	281556	811838	308.00	1942	1968	NE
146	02265000	SOUTH PORT CANAL AT S-61 NEAR ST CLOUD	280822	812106	620.00	1942	1968	NE
147	02266000	CANOE CREEK NEAR ST CLOUD	280422	811539	86.00	1950	1959	NE
158	02267500	KISSIMMEE RIVER NEAR LAKE WALES	280000	812250	n.d.	1942	1968	NE
162	02269000	KISSIMMEE R BL LAKE KISSIMMEE NEAR LAKE WALES	274613	811045	1607.00	1933	1969	NE
163	02269500	REEDY CREEK NEAR FROSTPROOF	274313	812840	60.00	1947	1972	NE
167	02271000	STEARNS CREEK NEAR LAKE PLACID	271922	812509	44.00	1955	1968	NE
170	02272000	ISTOKPOGA CANAL NEAR CORNWELL	272356	810945	n.d.	1934	1968	NE
171	02272500	KISSIMMEE RIVER NEAR BASSINGER	272152	810307	2709.00	1937	1964	NE
174	02273200	CANAL 41A AT S-68 NEAR LAKE PLACID	271955	811505	n.d.	1964	1989	NE
175	02273300	CANAL 41A AT S-84 NEAR OKEECHOBEE	271255	805855	n.d.	1964	1989	NE
176	02274000	TAYLOR CREEK NEAR BASINGER	272339	805344	15.00	1955	1989	NE
177	02274495	WILLIAMSON DITCH AT S-7 NEAR OKEECHOBEE	271745	804935	35.00	1964	1989	NE
178	02274500	TAYLOR CREEK AB OKEECHOBEE	271703	804920	98.00	1955	1982	NE
182	02276984	MONREVE RANCH DRAINAGE CANAL NEAR STUART	270340	801911	6.00	1959	1973	S
185	02277700	22 SW FORK LOXAHATCHEE R AT S-41 NEAR JUPITER	265602	800831	n.d.	1959	1965	S
186	02277900	CANAL M NEAR MAGNOLIA PARK	264500	800633	n.d.	1970	1977	S
195	02281300	10B HILLSBORO CANAL AT S-39 NEAR DEERFIELD	262120	801758	n.d.	1957	1967	S
197	02281500	HILLSBORO CANAL NEAR DEERFIELD BEACH	261939	800752	n.d.	1940	1991	S
198	02281700	POMPANO CANAL AT S38 NEAR POMPANO BEACH	261345	801750	n.d.	1962	1967	S
199	02282000	POMPANO CANAL AT POMPANO BEACH	261351	800728	n.d.	1964	1969	S
200	02282100	CYPRESS CREEK CANAL AT S-37A NEAR POMPANO BEACH	261220	800757	n.d.	1964	1985	S
206	02284700	NORTH NEW RIVER BELOW S-34 NEAR FT LAUDERDALE	260843	802629	n.d.	1956	1967	S
207	02285000	NORTH NEW RIVER CANAL NEAR FT LAUDERDALE	260539	801348	n.d.	1939	1992	S
208	02285400	SOUTH NEW RIVER CANAL AT S-9 NEAR DAVIE	260340	802630	83.00	1958	1970	S
210	02286150	HOLLYWOOD CANAL AT DANIA	260313	800919	n.d.	1962	1967	S
212	02286300	SNAKE CREEK CANAL AT S-29 AT NORTH MIAMI BEACH	255541	800922	n.d.	1959	1985	S
213	02286340	BISCAYNE CANAL AT S-28 NEAR MIAMI	255224	801055	n.d.	1962	1985	S
214	02286380	LITTLE RIVER CANAL AT S-27 AT MIAMI	255600	802550	n.d.	1960	1969	S
217	02286962	CANAL 60 AT S-140 NEAR FORT LAUDERDALE	261017	804942	n.d.	1970	1981	S
219	02287400	MIAMI CANAL AT BROKEN DAM NEAR MIAMI	255600	802550	n.d.	1960	1968	S
221	02287500	MIAMI CANAL AT PENNSUCO NEAR MIAMI	255340	802245	n.d.	1963	1979	S
223	02288200	MIAMI CANAL AT PALMETTO BYPASS NEAR HIALEAH	255111	801922	n.d.	1910	1981	S
224	02288500	MIAMI CANAL AT WATER PLANT AT HIALEAH	254938	801715	n.d.	1940	1959	S
228	02289000	TAMIAMI ÇANAL OUTLETS MIAMI TO MONROE	254600	805000	98.00	1940	1963	S
231	02289030	LEVEE 3 CANAL NEAR CLEWISTON	262550	805650	n.d.	1970	1990	S
240	02290530	MIAMI RIVER AT BRICKELL AVE. MIAMI	254511	801125	n.d.	1961	1966	S
241	02290560	CORAL GABLES CANAL AT RED RD NEAR CORAL GABLES	254417	801713	n.d.	1960	1970	S
242	02290580	CORAL GABLES CANAL NEAR SOUTH MIAMI	254220	801540	n.d.	1961	1966	S
243	02290600	SNAPPER CREEK CANAL NEAR CORAL GABLES	254540	802305	n.d.	1960	1967	S

Map ID	Station number	Station name	Latitude	Longitude	Drainage area (sq mi)	Period of record		USGS region code
						Start	End	
244	02290610	SNAPPER CREEK CANAL AT MILLER DRIVE NEAR S MIAMI	254256	802259	n.d.	1963	1981	S
245	02290700	SNAPPER CREEK CANAL AT S-22 NEAR SOUTH MIAMI	254011	801703	n.d.	1959	1985	S
247	02290725	MOWRY CANAL NEAR HOMESTEAD	252813	802047	n.d.	1970	1989	S
254	02290800	TAYLOR SLOUGH NEAR HOMESTEAD	252405	803625	n.d.	1960	1985	S
255	02290850	SHARK RIVER NEAR HOMESTEAD	252007	810644	n.d.	1960	1966	S
256	02290860	HARNEY RIVER NEAR HOMESTEAD	252520	810130	n.d.	1960	1967	S
257	02290950	ROBERTS LAKE SLOUGH NEAR MONROE	254705	810500	n.d.	1973	1980	S
259	02291143	FAKA UNION CANAL NEAR COPELAND	255759	813023	n.d.	1970	1984	S
260	02291270	HENDERSON CREEK CANAL NEAR NAPLES	260559	814114	n.d.	1968	1984	S
261	02291300	GOLDEN GATE CANAL AT NAPLES	261001	814602	n.d.	1965	1984	S
262	02291393	COCOHATCHEE R CANAL AT WILLOUGHBY ACRE BRANCH	261621	814553	n.d.	1969	1985	S
274	02293000	ORANGE RIVER NEAR FORT MYERS	264000	814356	60.00	1934	1946	S
281	02293346	HORSESHOE CANAL AT CAPE CORAL	264049	820219	n.d.	1987	1992	S
283	02293694	PEACE CREEK DRAINAGE CANAL NEAR DUNDEE	280150	813935	58.00	1947	1959	SW
284	02293986	PEACE CREEK DRAINAGE CANAL NEAR ALTURAS	275523	814228	160.00	1947	1972	SW
286	02294068	LULU LAKE OUTLET AT ELOISE	275903	814347	23.00	1947	1972	SW
294	02296223	LITTLE CHARLEY BOWLEGS CREEK NEAR SEBRING	272840	813325	41.00	1952	1983	SW
301	02298202	SHELL CREEK NEAR PUNTA GORDA	265904	815609	373.00	1965	1995	SW
302	02298608	MYAKKA RIVER AT MYAKKA CITY	272036	820925	125.00	1963	1978	SW
303	02298760	HOWARD CREEK NEAR SARASOTA	271717	822025	20.00	1984	1995	SW
304	02298805	MYAKKA RIVER BL UPPER MYAKKA LK NEAR SARASOTA	271550	821715	219.00	1946	1951	SW
306	02298850	MYAKKA R BL LOWER MYAKKA LK NEAR SARASOTA	271305	822000	240.00	1946	1951	SW
311	02299470	BIG SLOUGH NEAR MURDOCK	270415	821305	92.00	1963	1972	SW
315	02300000	MANATEE RIVER NEAR BRADENTON	272830	821805	87.00	1939	1966	SW
328	02300530	CYPRESS CREEK NEAR WIMAUMA	274227	822148	8.00	1981	1991	SW
332	02301350	LITTLE ALAFIA RIVER NEAR HOPEWELL	275615	820923	8.00	1966	1979	SW
335	02301695	BUCKHORN CREEK NEAR BRANDON	275336	821755	7.00	1985	1991	SW
337	02301800	SIXMILE CREEK AT TAMPA	275759	822207	28.00	1957	1974	SW
338	02301802	TAMPA BYPASS CANAL AT S-160 AT TAMPA	275721	822215	29.00	1975	1989	SW
344	02303100	NEW RIVER NEAR ZEPHYRHILLS	280955	821555	15.00	1964	1974	SW
346	02303300	FLINT CREEK NEAR THONOTOSASSA	280404	821603	60.00	1956	1991	SW
352	02303500	HANNA LAKE OUTLET NEAR LUTZ	280810	822635	n.d.	1946	1951	SW
356	02305000	HUTCHINS LAKE OUTLET NEAR LUTZ	280740	822915	2.00	1946	1952	SW
357	02305500	DR DITCH AT BEARS AVE NEAR SULPHUR SPRINGS	280516	822755	12.00	1946	1956	SW
358	02305780	CURIOSITY CREEK NEAR SULPHUR SPRINGS	280407	822724	n.d.	1981	1989	SW
360	02306289	LAKE MAGDALENE OUTLET NEAR LUTZ	280426	823001	2.00	1970	1982	SW
365	02306910	BRUSHY CREEK NEAR TAMPA	280410	823151	7.00	1982	1987	SW
369	02307243	BROOKER CREEK NEAR ODESSA	280850	823540	10.00	1946	1956	SW
370	02307323	BROOKER CREEK NEAR LAKE FERN	280826	823824	17.00	1970	1994	SW
372	02307498	LAKE TARPON CANAL AT S-551 NEAR OLDSMAR	280312	824240	60.00	1975	1989	SW
374	02307671	ALLIGATOR CREEK BELOW US HWY 19 AT CLEARWATER	275830	824341	6.17	1982	1996	SW
375	02307673	ALLIGATOR CREEK AT CLEARWATER	275822	824257	6.73	1980	1996	SW
376	02307697	ALLIGATOR CREEK AT SAFETY HARBOR	275845	824145	9.00	1950	1975	SW
377	02308889	SEMINOLE LAKE OUTLET NEAR LARGO	275020	824650	14.00	1950	1971	SW
378	02308935	ST JOES CREEK AT PINELLAS PARK	274850	824145	2.00	1984	1991	SW

Map ID	Station number	Station name	Latitude	Longitude	Drainage area (sq mi)	Period of record		USGS region code
						Start	End	
380	02309980	ANCLOTE RIVER NEAR ODESSA	281317	823807	68.00	1984	1994	SW
383	02310240	JUMPING GULLY AT LOYCE	282306	822922	43.00	1964	1986	SW
386	02310350	BEAR CREEK NEAR HUDSON	281910	823906	22.00	1965	1970	SW
387	02310352	BEAR CREEK AT PLAZA DRIVE NEAR HUDSON	281938	823959	29.00	1970	1978	SW
390	02310750	CRYSTAL RIVER NEAR CRYSTAL RIVER	285417	823813	n.d.	1964	1977	SW
391	02310800	WITHLACOOCHEE RIVER NEAR EVA	282138	814908	130.00	1958	1993	NE
399	02312194	BIG GANT CANAL AT STRUCTURE S-11 NEAR WEB	283447	820545	18.00	1970	1992	NE
400	02312197	BIG GANT CANAL AT STRUCTURE WC-2 AT RERDE	283416	820854	30.00	1970	1992	NE
404	02312635	JUMPER CREEK CANAL NEAR SUMTERVILLE	284146	820318	28.00	1976	1991	NE
406	02312645	JUMPER CREEK CANAL NEAR WAHOO	284215	820926	50.00	1979	1992	NE
408	02312690	CHITTY CHATTY CREEK NEAR WILDWOOD	284833	815859	38.00	1959	1992	NE
411	02312772	LESLIE-HEIFNER CANAL NEAR FLORAL CITY	284520	821350	n.d.	1983	1987	NE
415	02313237	BARGE CANAL AT INGLIS LOCK NEAR INGLIS	290130	823700	n.d.	1970	1992	NE
417	02313500	WACCASASSA RIVER NEAR OTTER CREEK	292115	824406	300.00	1944	1953	NW
419	02314000	OTTER CREEK AT OTTER CREEK	291908	824703	n.d.	1945	1953	NW
420	02314200	TENMILE CREEK AT LEBANON STATION	290939	823821	26.00	1964	1992	NW
421	02314986	ROCKY CREEK NEAR BELMONT	303240	824402	50.00	1976	1983	NW
423	02315005	HUNTER CREEK NEAR BELMONT	302908	824244	n.d.	1979	1988	NW
425	02315392	ROBINSON CREEK NEAR SUWANNEE VALLEY	301856	823841	27.40	1976	1981	NW
427	02315520	SWIFT CREEK AT FACIL	302214	824800	65.30	1976	1988	NW
429	02317620	ALAPAHA RIVER NEAR JENNINGS	303553	830424	1680.00	1976	1987	NW
432	02320000*	SUWANNEE RIVER AT LURAVILLE	300559	831018	7280.00	1927	1937	NW
439	02322000	SANTA FE RIVER NEAR HIGH SPRINGS	295033	823752	868.00	1931	1971	NW
440	02322016	BLUES CREEK NEAR GAINSVILLE	294341	822554	5.12	1984	1994	NW
443	02323000	SUWANNEE RIVER NEAR BELL	294728	825528	9390.00	1932	1956	NW
447	02324500	FENHOLLOWAY RIVER AT FOLEY	300355	833429	120.00	1946	1992	NW
450	02326500	AUCILLA RIVER AT LAMONT	302211	834825	747.00	1950	1982	NW
452	02326900*	ST. MARKS RIVER NEAR NEWPORT	301600	840900	535.00	1956	1990	NW
455	02329104	OX BOTTOM CREEK NEAR TALLAHASSEE	303302	841815	2.00	1973	1983	NW
456	02329161	FORDS ARM TRIBUTARY AT TALLAHASSEE	302959	841639	1.00	1973	1983	NW
457	02329180	MEGGINNIS ARM TRIB AT TALLAHASSEE	302840	841741	1.00	1975	1983	NW
458	02329186	MEGGINNIS ARM TRIB BL I-10 AT TALLAHASSEE	302906	841806	3.00	1973	1984	NW
459	02329500	LITTLE RIVER NEAR QUINCY	303514	842948	237.00	1950	1991	NW
460	02329534	QUINCY CREEK AT S267 AT QUINCY	303600	843450	16.80	1975	1992	NW
462	02329700	ROCKY COMFORT CREEK NEAR QUINCY	303244	843809	9.00	1964	1981	NW
465	02330300	NEW RIVER NEAR WILMA	300740	845345	81.00	1964	1981	NW
467	02358500	N MOSQUITO CANAL AT CHATTAHOOCHE	304208	844935	57.00	1936	1942	NW
472	02359450	ECONFINA CREEK NEAR FOUNTAIN	302855	853130	70.00	1965	1978	NW
474	02365200*	CHOCTAWHATCHEE RIVER NEAR PITTMAN	305659	855035	3209.00	1976	1981	NW
476	02366000	HOLMES CREEK AT VERNON	303735	854245	386.00	1950	1981	NW
479	02367000	ALAQUA CREEK NEAR DEFUNIAK SPRINGS	303700	860950	65.00	1951	1978	NW
480	02367006	ALAQUA CREEK NEAR PORTLAND	303322	861045	83.00	1977	1994	NW
481	02367310	JUNIPER CREEK AT STATE HWY 85 NEAR NICEVILLE	303326	863111	27.00	1966	1993	NW
482	02368000*	YELLOW RIVER AT MILLIGAN	304510	863745	624.00	1938	1993	NW
483	02368300	BAGGETT CREEK NEAR MILLIGAN	304340	863935	7.00	1965	1982	NW

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484	02368500	SHOAL RIVER NEAR MOSSY HEAD	304745	861825	123.00	1951	1978	NW
486	02369500	YELLOW RIVER NEAR HOLT	304025	864450	1210.00	1933	1941	NW
487	02370000*	BLACKWATER RIVER NEAR BAKER	305000	864405	205.00	1950	1992	NW
488	02370200	BIG JUNIPER CREEK NEAR MUNSON	305150	865420	36.00	1958	1967	NW
489	02370500	BIG COLDWATER CREEK NEAR MILTON	304230	865820	237.00	1939	1991	NW
490	02370700	POND CREEK NEAR MILTON	304050	870755	58.00	1958	1979	NW
492	02376000	PINE BARREN CREEK NEAR BARTH	304755	872205	75.00	1953	1994	NW
493	02376033*	ESCAMBIA RIVER NEAR MOLINO	304012	871600	4147.00	1960	1994	NW
494	02376100	BAYOU MARCUS CREEK NEAR PENSACOLA	302653	871726	10.00	1958	1991	NW
496	02376300	BRUSHY CREEK NEAR WALNUT HILLS	305321	873224	49.00	1958	1991	NW
501	260342081312500	FAKA UNION CANAL NEAR DEEP LAKE	260342	813125	n.d.	1978	1984	S

*Station will be reactivated in water year 1997.

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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