

StreamStats, Version 4

Introduction

StreamStats version 4, available at <https://streamstats.usgs.gov>, is a map-based web application (fig. 1) that provides an assortment of analytical tools that are useful for water-resources planning and management, and engineering purposes. Developed by the U.S. Geological Survey (USGS), the primary purpose of StreamStats is to provide estimates of streamflow statistics for user-selected ungaged sites on streams and for USGS streamgages, which are locations where streamflow data are collected.

Streamflow statistics, such as the 1-percent flood, the mean flow, and the 7-day 10-year low flow, are used by engineers, land managers, biologists, and many others to help guide decisions in their everyday work. For example, estimates of the 1-percent flood (which is exceeded, on average, once in 100 years and has a 1-percent chance of exceedance in any year) are used to create flood-plain maps that form the basis for setting insurance rates and land-use zoning. This and other streamflow statistics also are used for dam, bridge, and culvert design;

water-supply planning and management; permitting of water withdrawals and wastewater and industrial discharges; hydropower facility design and regulation; and setting of minimum allowed streamflows to protect freshwater ecosystems. Streamflow statistics can be computed from available data at USGS streamgages depending on the type of data collected at the stations. Most often, however, streamflow statistics are needed at ungaged sites, where no streamflow data are available to determine the statistics.

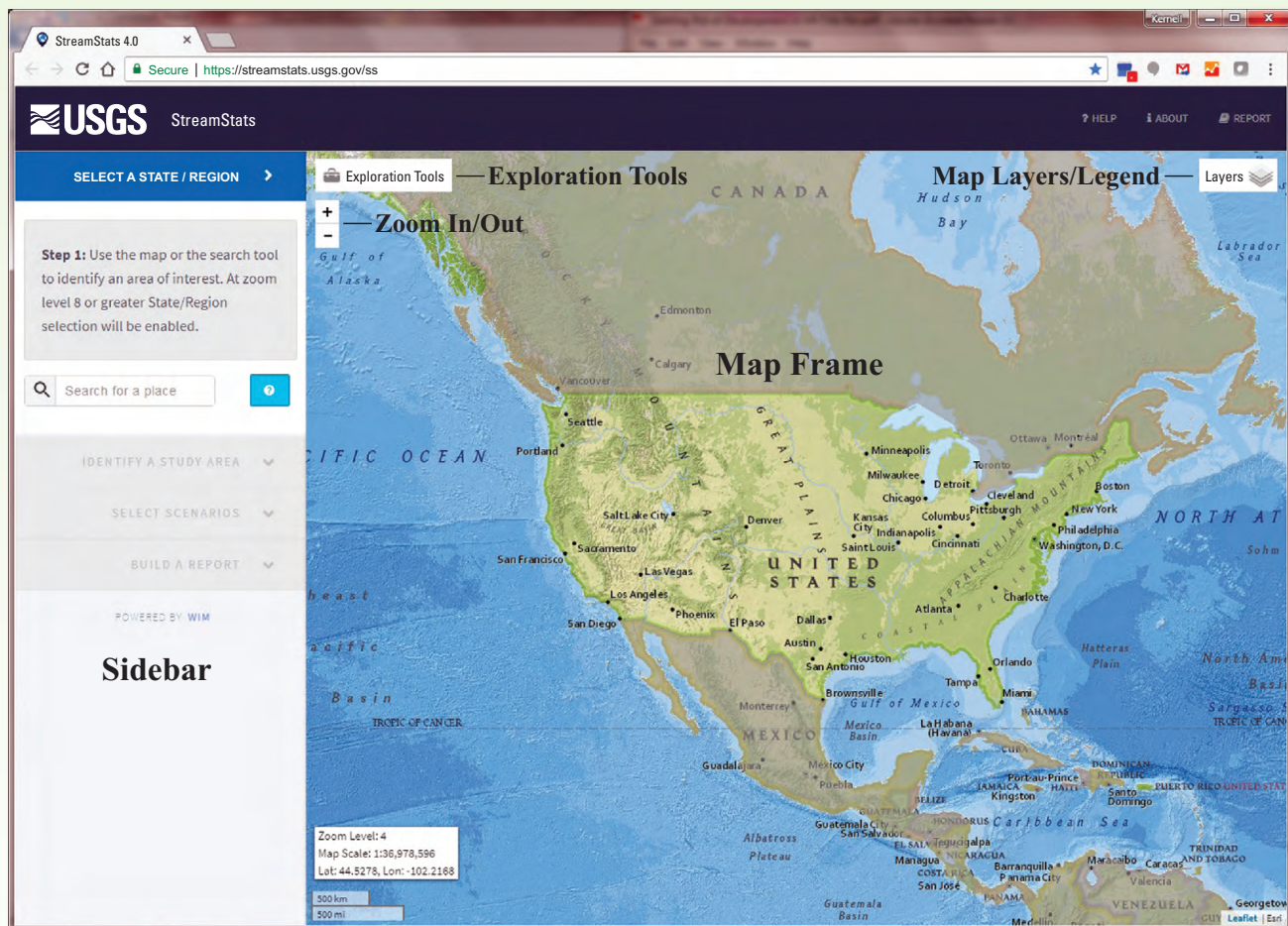


Figure 1. View of the StreamStats version 4 user interface at initiation.

Functionality

Ries and others (2004, 2008) described the development, functionality, and limitations for use of previous versions of StreamStats. Currently (2017), StreamStats version 4 includes Geographic Information System (GIS)-based tools that allow users to delineate drainage-basin boundaries for user-selected sites, compute a variety of basin characteristics, and estimate streamflow statistics for the selected site. StreamStats can perform these analyses much faster than historically used manual techniques. In addition, users can obtain descriptive information as well as previously published basin characteristics and streamflow statistics for USGS streamflow streamgages. These tools can be accessed through a map-based user interface that appears in the user's web browser (fig. 1), or individual tools can be accessed as web services by other web or desktop computer applications.

StreamStats includes additional tools that allow editing of delineated basin boundaries, and computing distances and elevation profiles between selected points on the map. Custom tools are available for some states. For example, tests for the presence of upstream regulation from dams are available for Colorado and Montana, and summaries of water withdrawals and discharges can be obtained for delineated basins in the Delaware River Basin and in northeastern Ohio. Several new tools that rely on navigation along the digital stream network are in development.

Web Site

The StreamStats home page provides a brief description of the application and some disclaimers about using it. The page also includes links to *News*, *Documentation*, *How it Works*, *Web Services*, *Batch Tool*, and *Help* pages. The *News* page provides information on changes to StreamStats, such as the addition of new states or methods for estimating streamflow statistics, operational problems, and anticipated disruptions of service. The *Documentation* page provides links to definitions of basin characteristics and streamflow statistics that appear in StreamStats outputs, this Fact Sheet, a users' manual, presentations and articles on StreamStats, and USGS internal resources. The *How it Works*

page describes the functionality that is available, how it works, the development strategy, outputs, and the StreamStats development team. The *Web Services* and *Batch Tool* pages describe how to use the StreamStats web services and batch tool, and provide access to those capabilities. The *Help* page provides information on how to obtain support for using StreamStats.

StreamStats User Interface

The StreamStats version 4 user interface (fig. 1) can display a variety of base maps and allows users to locate, select, and obtain information for gaged and ungaged sites of interest. The largest part of the interface consists of the Map Frame, which displays default and optional digital map layers, and allows the selection of sites of interest. In the top left corner of the Map Frame is the *Exploration Tools* button, and at the top right is the *Layers* button. Clicking on the *Exploration Tools* button reveals additional buttons for querying information for streamgages, measuring distances and obtaining elevation profiles between user-selected locations on the map, and showing your current location on the map. Clicking on the *Layers* button reveals buttons that allow turning on and off the digital map layers and defines the symbols that are shown for each layer.

Below the *Exploration Tools* button are the *Zoom In* and *Out* plus (+) and minus (-) buttons that allow making the scale of the map larger or smaller, respectively. The current scale and map zoom level are shown in a small text box at the lower left of the Map Frame.

The Sidebar (fig. 2), to the left of the map, is used primarily to zoom quickly to sites of interest and to obtain information for user-selected ungaged sites. The Sidebar presents a series of banners that, when selected, will turn from gray to blue and expose a panel of tool buttons and instructions on how to use them. The *Select a State/Region* banner at the top is activated initially, and contains a search tool that allows entering information about a location, such as an address, a zip code, or a state, zooming the map to that location, and selecting the state in which the site is located. When users complete using the tools under one banner, the next banner will activate automatically and expose its tools. The *Identify a Study*

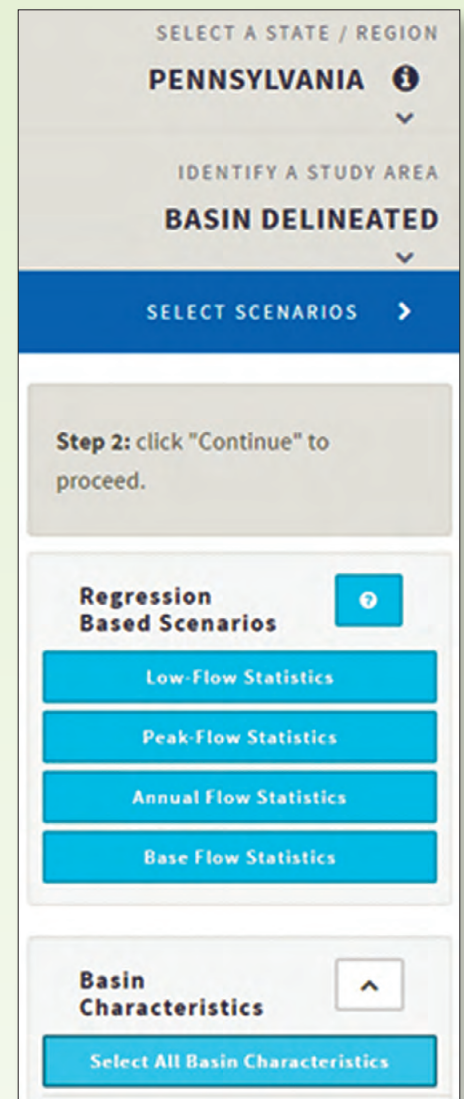


Figure 2. View of the StreamStats sidebar with the *Select Scenarios* banner activated and buttons for choosing the types of streamflow statistics and basin characteristics to be obtained.

Area banner allows delineating the drainage basin for a selected site, editing the delineated basin, and downloading the basin in a variety of formats that can be read by GIS applications. The *Select Scenarios* banner allows selection of the types of statistics to be estimated for the site based on regression equations, and the basin characteristics to be computed. The *Build a Report* banner allows selection of whether to include summaries of streamflow statistics, basin characteristics, or both, in the output report. The resulting report can then be printed, saved

to a machine-readable file, or exported with the delineated basin in a variety of GIS formats.

The *Help*, *About*, and *Report* links appear toward the right side of the black banner above the Map Frame. The *Help* link opens a page that provides access to the users' manual, a list of frequently asked questions and answers, and a form for submitting requests for support to the StreamStats development team. The *About* link opens a page that provides a very brief description of StreamStats, detailed information about the selected state or river basin, and news items about changes or upcoming events that may be of interest to users. Clicking on the *Report* link will cause StreamStats to generate a report that shows the results from whatever tools have been used up to the point at which the link was clicked.

This Fact Sheet does not fully describe how to use StreamStats. Complete documentation can be accessed through the links provided on the StreamStats home page and through the *Help* link on the user interface. It is highly recommended that users read the program documentation before attempting to use StreamStats. In particular, users who wish to estimate streamflow statistics for ungaged sites should review the information on the *State/Regional Info* tab that can be accessed from the *Help* link after selecting a state or region and the reports that are listed on the tab.

Information for Streamgages

Nearly 500,000 basin characteristics and 1.5 million streamflow statistics are available from StreamStats for more than 36,000 USGS streamgages nationwide. About 8,500 of the stations are currently operating streamgages where data are collected on a continuous basis, and about 12,000 of them are streamgages where data collection has been discontinued. Other station types include partial-record stations, and miscellaneous-measurement stations. Streamflow measurements are collected systematically over a period of years at partial-record stations to estimate peak-flow or low-flow statistics, or both. Streamflow measurements usually are collected at miscellaneous-measurement stations for specific hydrologic studies with various objectives. The station locations are displayed on the StreamStats Map Frame as various colored triangles

to indicate the station type. Simply clicking or tapping on a streamgage symbol on the map provides access to the available information, including descriptive information, basin characteristics, and streamflow statistics.

Available information varies among stations depending on the type of data collected at the station and the interests of local cooperating agencies who may have shared in the cost of computing the statistics. Descriptive information includes: the USGS station number, station name, station type, period of record, latitude, longitude, hydrologic unit code, county, directions to locate the station, and remarks indicating any effects of human impacts or other pertinent information about the station. All basin characteristics and streamflow statistics provided by StreamStats for USGS stations were previously computed and citations are provided for each value. More than 850 different types of basin characteristics and more than 2,650 different types of streamflow statistics are available for the stations, although individual stations usually have only a small number of them available.

Streamflow Statistics for Ungaged Sites

StreamStats relies on regional regression equations that were mostly developed and published by the USGS to estimate streamflow statistics for ungaged sites. Regression equations are developed by statistically relating the streamflow statistics to the basin characteristics for a group of streamgages within a region. Estimates of streamflow statistics for an ungaged site can then be obtained by measuring its basin characteristics and inserting them into the regression equations (see inset).

The tools provided in the StreamStats Sidebar automate the process for users to (1) locate their ungaged site of interest in the user interface, (2) delineate the drainage basin, (3) compute basin characteristics, (4) estimate flow statistics, and (5) produce an output report that provides a map of the delineated basin and summarizes the available information for the site. Depending on the size of the basin and the types of basin characteristics measured, this automated process can save from an hour to

a few days of work, compared to efforts needed to do the work manually.

StreamStats delineates the drainage-basin boundary for a selected site by use of an evenly spaced grid of land-surface elevations, known as a Digital Elevation Model (DEM), and a digital representation of the stream network. When a user selects a site along the digital stream network, the site location is transferred to a point in the DEM, and the DEM is then used to determine the drainage boundary. The DEM for most states has been enhanced by a process that ensures conformance to the stream network and a dataset of pre-existing drainage

Regression Equations

The USGS has developed equations to estimate peak-flow frequency statistics, such as the 100-year flood, for ungaged sites in every state. Regression equations also have been developed to estimate other types of streamflow statistics for many states. As an example, the equation for estimating the 100-year flood for ungaged sites in Vermont is

$$PK_{100} = 0.251 DA^{0.854} (S+1)^{-0.297} P^{1.089}$$

where

- PK₁₀₀** is the peak flow that occurs, on average, once in 100 years (1-percent change of occurrence in any year), in cubic feet per second;
- DA** is the drainage area, in square miles;
- S** is the percent of the basin covered by wetlands and water (storage); and
- P** is the mean annual precipitation, in inches.

Reference

Olson, S.A., 2014, Estimation of flood discharges at selected annual exceedance probabilities for unregulated, rural streams in Vermont, *with a section on Vermont regional skew regression*, by Veilleux, A.G.: U.S. Geological Survey Scientific Investigations Report 2014–5078, 27 p. plus appendixes, accessed May 18, 2017, at <http://dx.doi.org/10.3133/sir20145078>.

boundaries. This enhancement results in delineations that usually are of greater accuracy than delineations obtained from a standard DEM.

StreamStats version 2 previously included a tool that also was able to estimate streamflow statistics for ungaged sites on the basis of the flow per unit area at an upstream or downstream streamgage. That functionality is being redeveloped for version 4 and will be documented in the users' manual when it becomes available.

Limitations for Ungaged Site Estimates

StreamStats processes rely on the use of very large, complex datasets. These datasets mostly were developed by other entities internal and external to the USGS, and can contain occasional errors. Users are advised to carefully check all results for accuracy and to exercise their own professional judgment in evaluating the appropriateness of the results for their application. Basin delineations, in particular, can be erroneous. The web site provides tools and base maps useful for verifying the accuracy of the basin delineations and editing them.

Estimates of streamflow statistics that are obtained from regression equations are based on the assumption of natural flow conditions at the ungaged site unless the reports that document the equations state otherwise. If human activities such as dam regulation and water withdrawals substantially affect the timing, magnitude, or duration of flows at a selected site, the regression-equation estimates provided by StreamStats should be adjusted by the user to account for those activities.

StreamStats can be used to obtain estimates of streamflow statistics for USGS streamgages. Users should be aware that there are errors associated with estimates determined from available data for the stations as well as estimates

determined from regression equations, and some disagreement between the two sets of estimates is expected. If the flows at the stations are affected by human activities, then users should not assume that the differences between the data-based estimates and the regression-equation estimates are equivalent to the effects of human activities on streamflow at the stations.

In addition to estimates of streamflow statistics, StreamStats outputs for ungaged sites include indicators of the errors associated with the estimates, as well as values of the basin characteristics that are used as explanatory variables in the equations and the minimum and maximum values of those basin characteristics for the streamgages that were used to develop the equations. When one or more of the basin characteristics for an ungaged site are outside the given ranges, then the estimates are extrapolated. StreamStats provides warnings when extrapolation occurs. Although StreamStats does provide estimates of streamflow statistics in these circumstances, no error indicators are provided with them, as the errors associated with these estimates are unknown and may be very large.

Web Services and Batch Tool

The *Web Services* and *Batch Tool* links from the StreamStats home page provide access to instructions for using StreamStats web services and a batch tool, respectively. All StreamStats functionality is available as web services, meaning that other remote computer applications or web sites can initiate a request for a particular function over the Internet, and StreamStats can perform that function and deliver the result back to the remote application. As an example, an engineer could issue a request to obtain a basin delineation from StreamStats using a separate desktop mapping application and thus avoid the need to assemble and process the GIS

data that would be needed in the desktop application to determine the delineation.

The batch tool produces shapefiles that contain the delineated basins, basin characteristics, and flow statistics for multiple sites requested at once. Users need to upload a shapefile of points of interest that have been edited in a GIS so they are coincident with the StreamStats stream grid before running the batch tool.

References Cited

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Additional Information

For more information, visit the StreamStats website at <https://streamstats.usgs.gov/>.

ISSN 2327-6916 (print)
ISSN 2327-6932 (online)
<https://doi.org/10.3133/fs20173046>

Photographs by Edward J. Doheny, U.S. Geological Survey

Supersedes USGS Fact Sheet 2008–3067

