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U.S. Geological Survey
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USGS Maryland-Delaware-District of Columbia Water Science Center

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Base-flow estimation using optimal hydrograph separation with applications to Chesapeake Bay watershed and the continental U.S.

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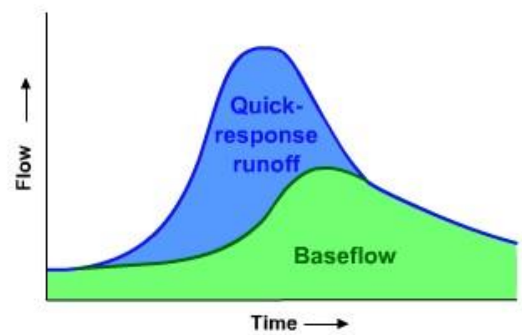

Quantitative estimates of base flow are necessary to address questions of the vulnerability and response of aquatic ecosystems to natural and human-induced change in environmental conditions as well as sustainability of water resources. Base flow is often defined as the portion of streamflow that is maintained between precipitation events, fed to stream channels by delayed (usually subsurface) pathways. Base flow is generally not measured directly, but is estimated from observations of streamflow and/or stream-water chemistry. Historically, a variety of hydrograph separation methods have been used to estimate base flow based on daily streamflow records. This presentation describes a new base-flow separation method developed by the U.S. Geological Survey based on a recursive digital filter (Eckhardt, 2005), with filter parameters estimated using base-flow recession analysis and an optimization approach constrained by chemical mass balance (using specific conductance). The method has been applied to 225 sites in the Chesapeake Bay watershed and the results used to quantify base-flow loads and trends, assist in development of dynamic and base-flow SPARROW (Spatially Referenced Regression on Watershed Attributes) models, and other applications. Base flow is of importance in Chesapeake Bay because approximately half the nitrate reaching the Bay has a groundwater source; the groundwater reservoir is relatively large compared to surface water and can have relatively long residence times, resulting in a lag between inputs at the land surface and observed changes in stream chemistry. More recently the method has been applied to more than 1000 streamgages in the continental US in support of the USGS National Water Census project. A summary of results from the national-extent base-flow time series will be used to guide calibration target ranges within the National Hydrologic Model with Precipitation-Runoff Modeling System (NHM-PRMS). Use of alternative data sources such as this base-flow dataset will allow for improved simulation of the broader water budget, leading to improved understanding of the components of streamflow.

Jeff Raffensperger has worked for the MD-DE-DC Water Science Center since 1999. He has led or collaborated on studies of hydrologic processes, water quality, and modeling. He has been a member of the National Water-Quality Assessment (NAWQA) Integrated Watershed Studies (IWS) Team, and the Water Budget Estimation and Evaluation (WBEEP) Team and is the Water Science Center Groundwater Specialist.

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