

# 1

## Introduction

The goal of the U.S. Geological Survey (USGS) streamgaging program is to provide streamflow information to educate and inform resource managers and the public on defining, using, and managing water resources. The USGS meets this goal with a network of gages and with staff scientists and collaborators to study streamflow and river processes. There are many beneficiaries of USGS information because streamflow affects human safety, recreation, water quality, habitat, industry, and agriculture. A short list of applications noted by users in Illinois (Knapp and Markus, 2003) included assessing cultural resources, biological and conservation assessment and in-stream flow needs, current operations of water resources, floodplain mapping, hydrologic and hydraulic design and modeling, legal obligations, long-term flow statistics, recreation, regional hydrologic analysis, river forecasting and flood warning, water quality analysis, water resources operations planning, and education.

However, the streamgaging program is now challenged to adapt to changing economic conditions. Funds are tighter, even as the U.S. population grows, stressing water supplies, affecting ecosystem health, and moving into marginal flood- or drought-prone areas (Figure 1-1).

Today, a mix of funding from federal, state, and local agencies supports the USGS streamgaging program. The vast majority of this funding (93 percent) comes from partnerships with state and local agencies through the Cooperative Water Program (<http://water.usgs.gov/coop>) and with federal agencies such as the U.S. Army Corps of Engineers and the Bureau of Reclamation (Figure 1-2). Partners (or “cooperators”) support streamgaging to obtain streamflow information that meets their needs; streamflow data from these streamgages also produce information that helps meet the

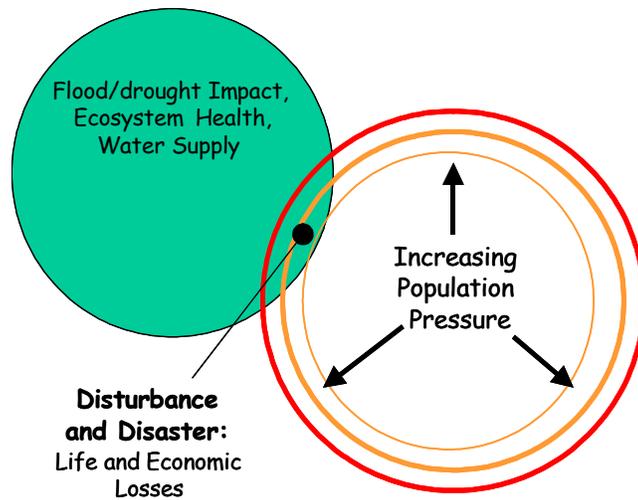


FIGURE 1-1 Life, economic, and habitat losses from increases in population near a river and within its watershed. The concentric circles are designed to show how increasing population begins to put pressure on other resources that were reasonably compatible with a smaller population. SOURCE: Adapted from USGS ([http://marine.usgs.gov/fact-sheets/nat\\_disasters/Circles.gif](http://marine.usgs.gov/fact-sheets/nat_disasters/Circles.gif)).

broader needs of the nation as a whole. This means that the siting of streamgages is driven more by the needs of partners than by an overarching plan for meeting the nation's need for streamflow information.

The USGS reported that the ability to meet federal streamflow information needs had been degraded because of (1) a decrease in the number of streamgages, (2) a disproportionate loss of streamgages with a long period of record, and (3) the declining ability of the USGS to continue operating high-priority streamgages when partners discontinue funding (USGS, 1998). Congress had also expressed its concern about "the steady decline in the number of streamgaging stations in the past decade, while the need for streamflow data for flood forecasting and long-term water management uses continues to grow" (U.S. House Appropriations Subcommittee on Interior and Related Agencies, 1998).

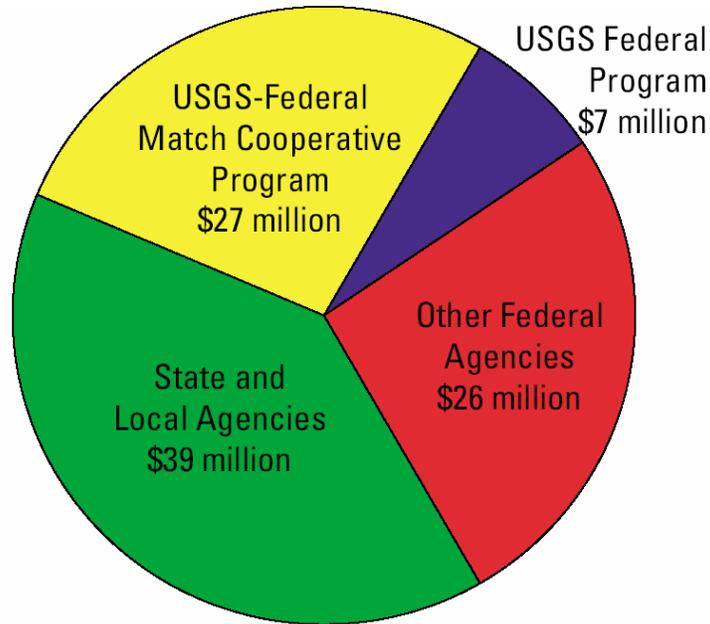


FIGURE 1-2 Fiscal year 2000 funding sources for the USGS streamgaging program (\$99 million). SOURCE: USGS. (<http://water.usgs.gov/nsip/pubs/F-S048-01.pdf>).

### THE NATIONAL STREAMFLOW INFORMATION PROGRAM

Recognizing the increasing needs for streamflow information, the USGS proposed the National Streamflow Information Program (NSIP) (USGS, 1999). The reference cited contains a general outline of the program, with specific numbers of gages recommended for different parts of the program. However, the present report may provide the most comprehensive description of the program that exists.

The NSIP plan has five components:

1. a nationwide system of federal interest streamgaging stations for measuring streamflow reliably and continuously in time;
2. a program for intensive data collection in response to major floods and droughts;

3. a program for periodic assessments and interpretation of streamflow data to better define their statistical characteristics and trends;
4. a system for real-time streamflow information delivery to customers that includes data processing, quality assurance, archiving, and access; and
5. a program of techniques development and research.

The streamgaging component of the NSIP proposal calls for a fundamental change in funding sources for the streamgaging program. The NSIP envisions a *federally funded base network* of streamgages designed to meet five minimum federal streamflow information goals for (1) interstate and international waters, (2) flow forecasts, (3) river basin outflows, (4) sentinel watersheds, and (5) water quality. A feature of the base network is the continuous, uninterrupted operation of its streamgages. Direct federal funding of these streamgages was proposed to remedy continuing losses of streamgages supporting these goals. The remainder of the USGS streamgaging network would consist of, as today, *cooperatively funded* streamgages. Cooperatively funded streamgages are designed to meet specific goals of federal, state, and local cooperators, and partnership with the USGS ensures that the streamgage data are quality controlled and available to all. Together, the base network and the cooperatively funded streamgages would meet many national needs for streamflow information (including the five federal goals).

The second component of the NSIP calls for intensive monitoring during times of major floods or droughts. Floods and droughts have serious social and economic impacts, including the loss of life and property, disruption of business activities, and interruption of water supplies. Intensive monitoring would include measuring streamflow where there are no permanent streamgages. Monitoring also would include gathering ancillary data on precipitation, river stage, and water quality. This component of the NSIP plan would support improved assessment of the risks, impacts, and mitigation of flood and drought hazards and provide new information for better scientific understanding of flood and drought processes and the effects of hydrologic extremes on river geomorphology and ecology. Much of the streamflow information generated by streamgaging results from careful analysis and synthesis of observations made at individual streamgages or a network of streamgages. The third component of the NSIP plan calls for periodic regional and national assessments of streamflow characteristics. Examples include regular updates of frequency estimates for low and high flows and regional synthesis to produce estimates of streamflow characteristics at ungaged sites. Assessments would also provide information on emerging scientific questions, such as the impact

of climate variability on the magnitude and frequency of floods and droughts. The value of streamflow information derives from its use in decisionmaking and scientific inquiry. In recent years, the USGS began distributing streamflow information over the Internet, and there has been a dramatic increase in the use of real-time and historical observations by the public, water managers, and scientists, among others. Thus, the fourth component of the NSIP plan calls for enhanced delivery of its streamflow data and information products.

The fifth component of the NSIP plan calls for methods development and research for streamgaging. A significant portion of the annual cost of streamgaging is making direct measurements of discharge at gage sites to maintain the rating curve used to convert continuous measurements of river stage into streamflow estimates. Recent advances in technology have the potential to reduce the costs and increase the safety of making discharge measurements. These include acoustic Doppler technology to quickly make discharge measurement on large rivers and approaches that do not require sensor contact with the flow (for safety) and could potentially be made remotely (to reduce the need for site visits).

## **STATEMENT OF TASK**

The National Research Council was asked to review the National Streamflow Information Program with respect to the following:

1. The minimum national streamflow information needs that should be met by the network, including those related to interstate and international waters, flood forecasts, river basin outflows, sentinel watersheds, and water quality.
2. The components of the NSIP plan that are reasonable, appropriate, and sufficient, including an enhanced nationwide streamgaging network with a larger share of national funding, intensive data collection during major floods and droughts, periodic regional and national assessments of streamflow characteristics, enhanced streamflow information delivery to customers, and methods development and research.
3. The ways a National Streamflow Information Program should support the data and information needs of various fields of river science, in addition to meeting its operational objectives.

## **ORGANIZATION AND CONTENT OF THIS REPORT**

This report examines the goals of the NSIP to ensure that they are being reasonably and efficiently met. It evaluates streamgaging network design, node (gaging station) design, and information delivery to consumers. It further addresses the tools to optimize the network design to maximize its efficiency and national coverage of streamflow and the technologies to improve gaging station efficiency and utility. To this end, a broad view is used of what might constitute a gaging station. The report examines interagency collaborations to effectively add nodes to the network. It looks at the merits of considering the streamflow program as primarily an *information* program, (i.e., data acquisition and analysis and information delivery), rather than as primarily a data-gathering program. Finally, it examines how streamflow information is used by consumers, to ensure that the needs of the public and water managers are both being met. Given that the NSIP has many beneficiaries, the study also addresses who should support it. Specifically, is there a rationale for federal support of a program that traditionally has been supported in large part by cooperators and beneficiaries?

Chapter 2 reviews the history of streamgaging at the USGS and examines the rationale for federal involvement in streamflow information by comparison with practice in other countries. Chapter 3 examines each of the five criteria used to select NSIP base network gage sites and studies the distribution of gage locations across the nation resulting from these criteria. Chapter 4 looks at the question of where to site streamgages and how long such sites should be maintained. Chapter 5 focuses on the other data collection and information components of the National Streamflow Information Program. Chapter 6 introduces the subject of river science and places the subject of streamflow information onto a background of the geomorphology and biology of stream and river systems. Finally, Chapter 7 presents the committee's conclusions.