Weaving the National Hydrologic Geospatial Fabric

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During the 1990s, many different federal, state and local organizations coordinated to develop nationally-consistent geospatial datasets for the Nation. The concept of leveraging local interest and knowledge to develop and then maintain these so-called national framework datasets was central to these efforts. This coordination was encouraged by the then recently re-sanctioned Office of Management and Budget Circular A-16, which established the Federal Geographic Data Committee (FGDC) and associated subcommittees to facilitate this collaboration. And it was embodied in the formative discussions that ultimately defined the National Spatial Data Infrastructure (NSDI).

The FGDC Subcommittee on Spatial Water Data (SSWD) fostered this collaboration by providing vision and guidance for a group of water-related national geospatial data development efforts that included the National Hydrography Dataset (NHD), the Watershed Boundary Dataset (WBD), and the National Elevation Dataset (NED). Since their initial release, these components of The National Map have played increasingly important roles in the management of water resources for the Nation – each adding a complementary part to the solution set needed to manage this complex and incredibly important resource. All are in the public domain and are intended to serve as multi-purpose resources that support a wide variety of applications and organizations. The NHD, WBD, and NED are described below along with two significant derived products (NHD*Plus* and StreamStats) that leverage these three foundational datasets to provide value-added data and tools for the water resources community. The data stewardship aspects of each are also described.

The initial **National Hydrography Dataset** (1:100,000-scale), which was released in 2000, was produced through a collaborative effort between U.S. Environmental Protection Agency (EPA), the U.S. Geological Survey (USGS), and several cooperating states, which had data improvements to contribute. It provided, for the first time, a rich set of named surfacewater features for making maps, a robust stream addressing scheme for linking water-related features such as water quality monitoring stations to streams, and a national stream network for discovering and analyzing these linked data through upstream and downstream searches. The success of the initial dataset generated interest in developing a more detailed NHD and led the U.S. Forest Service to partner with the USGS and numerous state cooperators to produce a high resolution NHD (1:24,000-scale or better) completed in 2007. The states that helped produce NHD now support its maintenance through a USGS-led data stewardship program that provides guidance, tools and coordination. EPA, USGS and the larger NHD community continue to link water-related features, including stream gages, dams, diversions, additions, and water quality assessments and impairments, to the NHD network adding to the list of potential applications and analyses. The NHD is being integrated along the borders of Mexico and Canada with similar hydrologic datasets from those countries. For more information on the NHD, visit nhd.usgs.gov.

The initial **Watershed Boundary Dataset** was released in 2009, resulting from a coordinated effort of the USGS, the Natural Resources Conservation Service, the EPA and the states. The WBD consists of six nested levels of hierarchical drainage boundaries encompassing all surface area for the Nation. Each level is subdivided into hydrologic units of uniform size based on topography and hydrologic principles. This establishes a base-line drainage boundary framework. Line placement has been carefully coordinated and negotiated in order to meet the needs of multiple organizations. Hydrologic units are delineated at 1:24,000-scale in the conterminous United States, 1:25,000-scale in the Caribbean, and 1:63,360-scale in Alaska. The WBD supports numerous programmatic planning, implementation, and reporting activities at the national, regional and local levels, and provides the structure for multiple analytical and statistical purposes and applications. The upstream and downstream relationship between each hydrologic unit is provided enabling 'network' queries in support of these applications. The states that helped produce the WBD now support its maintenance through the same USGS-led data

stewardship program established for the NHD, providing guidance, tools and coordination. The WBD is also being integrated along the borders of Mexico and Canada with similar hydrologic unit datasets from those countries. For more information on the WBD, visit *http://pubs.usgs.gov/tm/tm11a3/* for data standards, and ftp://ftp.ftw.nrcs.usda.gov/wbd for data retrieval.

The **National Elevation Dataset** is the primary elevation data product of the USGS. The NED is a seamless dataset with the best available raster elevation data of the conterminous United States, Alaska, Hawaii, and territorial islands. The NED is updated on a nominal two month cycle to integrate newly available, improved elevation source data. The NED is derived from diverse source data that are processed to a common coordinate system and unit of vertical measure. NED data are available nationally (except for Alaska) at resolutions of 1 arc-second (about 30 meters) and 1/3 arc-second (about 10 meters), and in limited areas at 1/9 arc-second (about 3 meters). A recent focus on Alaska elevation, has resulted in specific areas of elevation data at 1-, 1/3-, and 1/9-arc-second resolution with the remainder of the state at 2-arc-second (about 60 meters). Plans are to continue these improvement efforts for Alaska. The NED provides basic elevation information for earth science studies and mapping applications in the United States. For more information on the NED, visit ned.usgs.gov.

The **National Hydrography Dataset Plus *(NHDPlus)***, first released in 2006, is a suite of geospatial products that build upon and extend the capabilities of the NHD, WBD and NED. NHD*Plus* was developed to support the estimation of stream flow volume and velocity used in pollutant dilution (fate-and-transport) modeling. Since NHD*Plus* is produced from static snapshots of the NHD, WBD and NED, it includes the features and capabilities described above for these datasets. NHD*Plus* integrates the vector NHD stream network and WBD hydrologic unit boundaries with the gridded land surface as represented by the NED. This hydrologically-conditioned surface enables the delineation of a catchment (local drainage areas) for each NHD stream segment. The catchments are used to associate precipitation, temperature and runoff data with each stream segment for estimating stream flow. Elevations along each stream are used to compute stream slope for estimating velocities used in time of travel analyses. In addition to stream flow, NHD*Plus* provides additional value-added attributes, including stream order and a group of attributes that facilitate rapid stream network traversal and query. NHD*Plus* catchments can be used to associate other landscape attributes, such as land cover, with stream segments. Desktop and Internet-based tools, including Web services, are available. Potential updates to NHD and WBD that are identified during NHD*Plus* production or by users are coordinated with the USGS-led data stewardship program. For more information on the NHD*Plus*, visit http://water.epa.gov/scitech/datait/tools/waters/docs/basic_information.cfm.

StreamStats is a Web-based Geographic Information System (GIS) that provides users with access to an assortment of analytical tools that are useful for water-resources planning and management, and for engineering design applications. StreamStats relies upon integrated streams, hydrologic unit boundaries, and elevation data – usually the high-resolution NHD, the WBD, and the NED – to support these capabilities. Some state StreamStats applications use NHD*Plus* data for this purpose. StreamStats allows users to easily obtain actual or, in their absence, estimated streamflow statistics, drainage-basin boundaries and characteristics, and other information for user-selected sites on streams. In addition, StreamStats includes several tools that allow stream-network analysis and data discovery. Implementing StreamStats usually depends upon funding through cooperative agreements with local agencies. Some state applications include unique functionality. The initial state StreamStats application was completed for Idaho in 2004 and by 2011 24 states had been implemented. In addition to the state applications, a separate application has been established for serving information for USGS data-collection stations throughout the Nation. For more information on StreamStats, visit streamstats.usgs.gov.

Coordination and leveraging of data and tools between these projects has enabled much of the progress described for each. We anticipate more convergence of these collective activities over time to maximize such opportunities that will enable more effective management of the Nation's water resources.