

USGS National Hydrography Dataset Newsletter
Vol. 12, No. 10, August 2013
by Jeff Simley, USGS

Twentieth Anniversary of the NHD!

The year was 1993. Digital geospatial datasets were primarily designed for digital cartography and revolved around ways to put the traditional map in digital form. This would dispense with the photolithography process of mapmaking, allow construction and editing in a digital environment, and greatly improve the efficiencies of cartography. The U.S. Geological Survey produced the Digital Line Graph (DLG) to do this for the topographic map. For convenience it put the contours in one file, the transportation in another file, and the hydrography in yet another file. In the meantime over at the U.S. Environmental Protection Agency it was found that by taking the lines that made up the streams on USGS 1:250,000-scale maps, connecting them into a network, and putting flow direction on them, it was possible to analyze the movement of contaminants. In effect, they had ushered in the era of the Geographic Information System (GIS) to use the computer to detect and report on the interactions of data.

The EPA found that the better the data, the better the analysis. So it turned to the USGS, which was in the process of digitizing 1:100,000-scale maps for the U.S. Census, for a more accurate representation of surface water. In addition, the USGS realized that the rather simple DLG specification could be improved upon and was also in the process of developing the DLG-F feature-based data model that would make the geospatial data more applicable to GIS.

So it was that the USGS and EPA met to discuss how they might collaborate to leverage their common interests. It was immediately discovered that each agency could help the other even more than expected. The USGS had the digital surface water linework in the ongoing DLG program and was thinking outside of the box when it came to data modeling. The EPA was responsible for the Clean Water Act and had the requirement for advanced analysis of the nation's waters, plus it had already developed a successful implementation for analysis known as the River Reach File. This drove the development of an entirely new concept for a hydrography dataset. One that would serve computer algorithms for associating multiple data inputs to perform analysis while organizing and storing data in a geographic context based on nationwide standardization. A key concept was that this was not just the USGS and EPA, but anyone conducting surface water analysis could use this system anywhere in the country. The resulting dataset would be in the public domain.

After 1993 the concepts matured into what is now known as the National Hydrography Dataset. A key component of the NHD would be the development of a data model and a platform on which to house the data model. At the time, the NHD concept was a few years ahead of commercial data platforms so the decision was made to develop a home-grown data management system. As this was developed, tools would be needed to transfer valuable attributes from both the USGS DLG files and the EPA's River Reach files into a single dataset through the process of conflation. The workload to generate the new NHD was basically split between the USGS and EPA. Processing commenced in 1997 and by 2000 the dataset was in place and ready to distribute. A few years later the data management system was converted to a commercial based platform.

As the 1:100,000-scale NHD, now known as the medium resolution NHD, was being produced, the USGS and EPA were already thinking of next steps. For the USGS, the goal was to produce the NHD based on 1:24,000-scale geospatial data, now known as the high resolution NHD. The USGS didn't have to twist many arms to do this. Largely based upon the success of the medium resolution NHD, dozens of federal, state, and local agencies were lined up at the door willing to contribute money to the effort. In particular, the U.S. Forest Service had a strong need for the high resolution NHD. This accounted for

roughly one fifth of the hydrologic units in the country. The states rapidly filled the remaining holes, contributing both data and funding. By 2007, the nation had high resolution coverage. Almost immediately a number of states began working on even higher resolution NHD leading to local resolution NHD nominally in the 1:5,000-scale range. The need for local resolution NHD comes from the desire to include more intermittent and ephemeral streams left off the topographic maps. It is made possible by the advent of Light Detection And Ranging (LiDAR) data that provides for a highly detailed representation of the earth's surface and the channels that incise it.

At the EPA the future saw the need for integration of the hydrography and associated data with the landscape, notably the terrain. By doing this, the local drainage area (catchment) could be calculated for each stream in the NHD from digital elevation and hydrologic unit data. This allowed many landscape attributes to become associated with the stream segment and its catchment. Through data modeling it then became possible to calculate flow volume and velocity for each of the stream segments. This gave the EPA extended new powers in analysis. It allowed the modeling of contaminant concentrations in streams and their time of travel downstream. This enhanced NHD dataset, known as the NHDPlus, has since been processed into its second version released in 2012.

The development of the NHD in 1993 was a turning point in GIS, when geospatial data was transformed from digital cartography to a true analysis-ready dataset. The NHD and NHDPlus are used extensively in hydrology, resource management, fisheries biology, pollution control, emergency management and cartography, and has in many ways revolutionized how the science is conducted. Every month over 4-million 7.5-minute quadrangles worth of NHD are downloaded by users across the spectrum of GIS. Now efforts are underway to plan for the next 20 years of the NHD and NHDPlus. That will likely lead to a better integration of geospatial data and data that is richer in content to feed the enormous appetite of GIS.

Network Improvement Project Status by David Kraemer

Region 20 (Hawaii) was completed this month. The complete list of regions completed is: 06, 07, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 20. The Network Improvement Project is planning on completing 49 states and all US territories by the end of September; except for those areas checked out by states and the Canadian border (see below).

Remaining Region Completion Percentages

- 01 – 80% – On Hold – Remaining sub-basins will be completed after the Canadian border harmonization
- 02 – 85% – In Work
- 03 – 85% – In Work – Some sub-basins checked out by Alabama and Florida
- 04 – 80% – On Hold – Remaining sub-basins will be completed after the Canadian border harmonization
- 05 – 90% – On Hold – Some sub-basins checked out by Indiana
- 08 – 35% – In Work – Some sub-basins checked out by Arkansas, Louisiana, and Mississippi
- 21 – 40% – In Work
- 19 and 22 – To be started soon

Current Issues

As the states check-in their jobs Network Improvement will finish the uncompleted Regions. Alaska Network Improvement should begin in late September. Put on hold are all sub-basins along the northern border where the border is a 2-D feature, because both Canada and the United States have compiled polygons for these features. Once the Canadian hydrography has been moved to a different feature class those sub-basins will be edited. The NHD Stewardship page does not allow check-outs of adjoining sub-basins if those sub-basins are in different sub-regions. So it has not been possible to check the network connections between sub-regions.

Realignment of Stewardship Points of Contact by Paul Kimsey

The Partnership Support Section within the USGS National Geospatial Technical Operations Center (NGTOC) coordinates NHD partner activities and provides technical support to partner organizations. Effective October 1, 2013, this section will be realigned to include four NHD technical support regions as shown below. The USGS NHD points of contact for the regions will be:

Region 1 – Hank Nelson, 303-202-4448, hpnelson@usgs.gov

ND, SD, WY, MT, ID, WA, OR, NV, CA, AK, HI

Region 2 – Bill Smith, 303-202-4493, wjsmith@usgs.gov

NE, KS, OK, TX, CO, NM, UT, AZ

Region 3 – Joel Skalet, 608-238-9333 x 152, jjaskalet@usgs.gov

ME, NH, VT, MA, RI, CT, NY, NJ, PA, OH, MI, IN, IL, WI, MN, IA

Region 4 – Dave Arnold, 573-308-3533, darnold@usgs.gov

DE, MD, VA, WV, NC, SC, GA, FL, KY, TN, AL, MS, MO, AR, LA

David Anderson, 573-308-3598, danderson@usgs.gov, will provide Geo Conflation support nationwide to partners that are interested in large scale (Local Resolution) data being incorporated into the national NHD database. Stephen Daw, 303-202-4418, sgdaw@usgs.gov, will continue to provide nationwide support for the Watershed Boundary Dataset (WBD). Paul Kimsey, 303-202-4560, pjkimsey@usgs.gov, is the overall manager of these partnership support activities, and may be contacted for more information or questions about this realignment.

WBD Update by Stephen Daw

The editing moratorium is lifted and all stewardship operations related to checking-out, editing and posting updates to the WBD are again available to WBD stewards. Please uninstall any previous versions of the WBD ArcGIS tools currently installed and install the latest version available from the stewardship website, <http://usgs-mrs.cr.usgs.gov/stewweb/>. The main reason to update the WBD tools is file delivery size. The new tools send back to USGS a much smaller file with only the essential data. This is necessary to avoid FTP time-out and security issues; nevertheless, should ftp issues arise, please try sending the job again. It may take several tries for a job to successfully upload due to network traffic, Department of Interior firewalls, or timing. Training is available for the stewardship process, including how to use the WBD ArcGIS tools. Please contact Stephen Daw, sgdaw@usgs.gov, if you would like to attend a training class.

NHD Viewer Cartographic Updates – Coming soon! by Kathy Yoder

The [NHD Viewer](#) services have recently gone through a series of cartographic updates in order to improve the value of both the basemap and overlay services. The basemap is currently undergoing an eight week long caching process. Once this process is over, the new services will go live on the NHD Viewer. The main enhancements made to the viewer services include:

- HUC boundary symbology was changed from red to a purple so that HUC boundaries are more distinguishable from transportation features.
- Major Rivers are labeled at small scales.
- Hydro feature labels are italicized.
- Point features turn on at a larger scale.
- Label colors and some feature symbologies have been changed.

You can expect to see these updates go live in FY14 Quarter 1, at which point the NHD will tweet that the services are live. For questions or comments on the NHD Viewer, please contact Kathy Yoder at kyoder@usgs.gov.

Headwater Streams

A paper published in the August 2013 edition of the Journal of the American Water Resources Association discusses the underrepresentation of streams found in the National Hydrography Dataset and issues in the flow permanence of the streams in the NHD. The paper notes the importance for such streams assuming “accurate documentation of the geographic extent of headwater streams and their hydrologic permanence is fundamental to Clean Water Act jurisdiction, as well as national water quality monitoring and improving water quality models.” Assessments were carried out on 207 streams in two areas; one in the Indiana-Ohio-Kentucky tri-state area and the other in western Oregon. Synthetic stream networks were created from digital elevation models and those streams had their flow permanence checked in the field. This synthetic network was then compared to the high and medium resolution NHD. The results showed that many streams that could be considered headwater streams were missing from the NHD. The study also found that the bulk of these headwater streams were ephemeral.

From a NHD program perspective these results are entirely consistent with the character of the NHD. While synthetic networks may show one thing, the NHD stream network was field verified when the original maps were made and the streams represent where water can be found much of the year. These original maps were constructed with a considerable network of added drainage lines, often accounting for 30% of the drainage network, used for the shaping of the contours. Those contours are often used to create DEMs that allow the creation of synthetic streams. For the map many of these drainage lines were removed (a) because they did not contain water other than in ephemeral flow and the contours showed the terrain, and (b) the stream network needed to be generalized to provide clarity at the given map scale. NHD stewards are actively producing local-resolution NHD to add additional ephemeral headwater streams as well as improving the accuracy of existing streams in the NHD. Notable examples are in Vermont, North Carolina, New York, Indiana, Mississippi, Iowa, Arkansas, and Oregon. In addition the U.S. Forest Service addresses this nationwide with its crenulated stream program.

The citation for the study is: Fritz, Ken M., E. Hagenbunch, E. D’Amico, M. Reif, P.J. Wigington, Jr., S.G. Leibowitz, R.L. Comeleo, J.L. Ebersole, and T.L. Nadeau, Comparing the Extent and Permanence of Headwater Streams from Two Field Surveys to Values from Hydrographic Databases and Maps, *Journal of the American Water Resources Association*, 49, 4, 867-882, 2013.

USGS Hydrography Grants by Steve Aichele

During Fiscal Year 2013, The National Geospatial Program supported eighteen NHD and WBD projects across the country with almost \$800,000 in grants. These projects focused on building stewardship; increasing the value of the NHD and WBD to users with improved attribution and improved feature content, particularly engineered features; and continuing to explore methods for extracting hydrographic features from LiDAR and IfSAR data. Each month the NHD Newsletter will examine a few of the grants:

Several projects also seek to lay the groundwork for future efforts. The West Virginia Natural Resources Analysis Center at West Virginia University is cooperating with local, state, and Federal stakeholders across West Virginia to transition from the desktop-based Watershed Characterization and Modeling System to an NHD-based StreamStats implementation. This work builds on 10 years of NHD stewardship and the recently developed statewide NHD business plan.

The USGS Georgia Water Science Center will be working with the Department of the Interior's WaterSmart initiative to develop methods for addressing water use and diversion data to the NHD and WBD. This work will build off of existing WaterSmart projects in the Apalachicola-Chattahoochee-Flint (ACF for short) watershed and a robust state-wide inventory of water use. The resulting template will be employed nationwide as the WaterSmart initiative is implemented. In FY14 we anticipate the addition of watersheds for many USGS monitoring locations into the WBD. The Idaho Water Science Center (WSC) will be doing some preliminary work to develop a process for other WSCs to apply.

Downloads of NHD Data from the USGS in July

During July there were 2,074 downloads of state-based high resolution NHD and 135 medium resolution downloads using file geodatabase. There were 1,747 subregion-based high resolution downloads and 425 medium resolution downloads for file based. There were 78 high resolution subbasin and 47 medium resolution subbasin downloads for personal geodatabase. That's a total of 4,506 datasets downloaded by FTP download. To give an idea of the geography this represents, it is the equivalent of over 3,605,000 quadrangles of coverage, all in a single month.

Also during the period there were over 1,961 downloads from The National Map viewer, with 1,295 by rectangle extracts of various sizes and 666 by subbasin or county. That brings the download total to 6,467 for June.

NHD Photo of the Month

This month's photo is an obscure, unnamed, and abandoned, ditch crossing the Continental Divide in Colorado. The ditch was built to divert snowmelt off the high western slopes of the Continental Divide, cross the divide at the notch, and deliver it to the eastern slope. Most likely this diversion was an attempt by some water user on the eastern slope to establish a water right to a certain portion of the flow on Boulder Creek, which drains the basin just over the ridge. 13,294 foot James Peak is in the background. To see the photo of the month go to ftp://nhdftp.usgs.gov/Hydro_Images/JamesPeak_123.JPG. Submit your photo for the NHD Photo of the Month by sending it to kyoder@usgs.gov. This will allow the program to build a library of real-world photos linked to the NHD.

July Hydrography Quiz / New June Quiz

David Asbury of Esri was the first to guess the July NHD Quiz as the harbor and Intercoastal Waterway in Miami, Florida on the Atlantic Ocean, better known as Biscayne Bay. See <ftp://nhdftp.usgs.gov/Quiz/Hydrography96.jpg>

David Asbury is a member of the Esri [Story Maps](#) team, helping individuals and organizations tell their geographic stories in compelling and engaging ways using easily configured, open source, web mapping applications. He also helped build the [World Hydro Basemap](#) on ArcGIS Online that incorporates the [NHD Plus v2](#). In his previous incarnation he used the NHD extensively while mapping steelhead habitat in coastal California.

Others with the correct answer (in order received) were: James Simard, Craig Johnston, Jon Becker, Tom Christy, Jonathan Labie, Dave Straub, Adam Oestreich, David Asbury, Diego Portillo, Jim Sherwood, Andy Woeber, Anji Auger, Rob Dollison, Bill Samuels, Evan Hammer, John Griffin, Rich Stein, Ken Koch, Jim Seay, Jim Sherwood, Kitty Kolb, Al Rea, Keith McFadden, Dennis Dempsey, Steve Aichele, Daniel Button, Matt Rehwald, Tom Falk, Bruce Tuttle, Edwin Abbey, Christina Boggs, Marc Weber, and Roger Barlow.

This month's hydrography quiz can be found at <ftp://nhdftp.usgs.gov/Quiz/Hydrography97.jpg> . Where is this harbor? Send your guess to jdsimley@usgs.gov.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Thanks to Paul Kimsey, David Kraemer, Stephen Daw, Steve Aichele, John Varndell, Gary Ott, and Kathy Yoder.

The NHD Newsletter is published monthly. Get on the mailing list by contacting jdsimley@usgs.gov.

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Jeff Simley, USGS, assumes full responsibility for the content of this newsletter.