A Partial Summary of 2012 USGS Activities

of Interest to the FHWA and State Highway Agencies

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Introduction

Part of the mission of the U.S. Geological Survey (USGS) is to assess the quantity, quality, and trends of the Nation's water resources, to advance the understanding of natural processes related to these resources, and to provide information that will assist resource managers and policymakers in making sound decisions.

The USGS has a long history of funded investigations with the Federal Highway Administration (FHWA) and State highway agencies to provide data and information to address various issues related to water resources and the Nation's transportation infrastructure. These issues cover a wide spectrum and include items such as regional flow statistics, flood documentation, regional stream characteristics, bridge scour, and water-quality assessments. For example, on a national scale the USGS is supporting efforts to enhance and maintain the National Streamflow Statistics Program, the StreamStats flow statistics application and delivery tool, and WaterAlert, a tool for automatic notification of threshold exceedance for stream stage, streamflow, and other water-related data collected by USGS.

On a regional scale, the USGS is conducting investigations to update Bulletin 17B skew maps, to define channel characteristics at bankfull discharge, and to document storm tide as a result of major coastal storms. Current locally focused investigations include the examination of rural, urban, and small watershed flow frequency; the documentation of extreme inland floods along with flood-frequency updates; and the development of flood inundation maps to assist with the protection of public infrastructure, such as roads and bridges, and to improve public safety.

The following table and text provide a partial summary of current or recently completed USGS activities related to highway issues. Table 1 organizes the current and recent activities into categories and subcategories and gives a quick overview of the USGS programs and the State and (or) Federal agencies that are helping sponsor the programs. The text following table 1 provides more detailed information on the various activities. The text initially describes activities that have been or are being conducted on a national level and is followed by state activities listed alphabetically by State. If you should have questions regarding this information, please contact Robert Mason (rrmason@usgs.gov).

Table 1. Partial summary of USGS activities of interest to the FHWA and State Highway Agencies

Project Type	Sponsoring Agencies/States
Regional Flow Frequency/Statistics Investigations	
- National Streamflow Statistics (NSS) Program	USGS
- StreamStats Program/automated basin characteristics	AL, AR, AZ, CA, CT, CO, FL, GA, HI, IA, IL, ID, IN, KS, KY, MA, MD, MN, MS, MT, NC, ND, NH, NJ, NM, NY, OH, OK, OR, PA, RI, SD, TN, UT, VA, VT, WA, WI
- Investigation of rural flow-frequency	CA, HI, IA, KS, LA, MO, MA, MT, MS, NC, NE, NM, NY, OK, OR, PA, SD, TN, TX, VA, WI, WV, FEMA
- Investigation of urban flow-frequency	IL, KS, NC, SC, VA
- Investigation of small watershed flow-frequency	KS, ME, MT, TN, TX
- Non-stationarity of peak flows	ME
- Updating Bulletin 17B Regional Skew Map	AK, AZ, MO
- Development of urban dimensionless unit hydrograph	MO
Bridge Scour and Sediment Transport	
- Evaluation of abutment-scour equations	SC, NCHRP
- Near real time scour monitoring	AK, MO, MS, MT, NJ
- Data collection and analysis	AK, ME, MN, MO, MS, MT, NE, NJ, NV, SC, SD, WA, FHWA
- Investigation of scour in cohesive soils using the EFA	IL
- Channel stability and scour assessment	AK, IN, MO, MS, MT, ND, NJ, NE, SD, TN, WA
- Investigation/modeling of sediment transport	MT, ND, TN, TX, WA
Hydrologic and Hydraulic River Investigations	
- Investigation of bridge site hydrology and hydraulics	AL, AR, MN, MO, MT, MS, TX
- Investigation and modeling of multi-dimensional flows	AK, AR, ID, MO, ND, PA
- Flood documentation	AR, IA, IN, MN, MT, NM, NY, NV, OR, PA, TN, WA, WI
- Operational flood inundation mapping	GA, IL, IN, KS, ME, MI, MO, MS, NC, NH, NJ, NY, OH, PA, WA
Stream Characteristic Investigations	
- Regional channel characteristics/bankfull discharge	ID, NY, OR, TX, WV
- Investigation of Manning's roughness coefficients	IL
Tidal Gages and Streamgages	
- Tidal gages	FL, NC
- Crest stage gages to estimate annual peak flows	AK, AL, FL, GA, HI, IA, ID, KS, LA, ME, MI, MN, MS, MO, MT, NV, NJ, NM, NY, OH, PA, SC, SD, TN, TX, UT, VT, VA, WI, WV
- Continuous-record discharge and stage gages	AK, HI, IA, ID, IN, LA, ME, MD, MI, MN, MS, MO, MT, NC, NH, NJ, PA, SC, TN, TX, UT, VT, WV
Water Quality and Environmental Investigations	
- Evaluation of stormwater runoff models	MA, OR, TX, FHWA
- Monitor water quality/quantity at selected sites	FL, HI, ID, MA, ME, MI, MN, MO, MT, NC, NV, PA, SC, TN, UT, VT, WA, WI
- Investigation of wetland impact/remediation	MT, WA
- Investigation of stream restoration	ID, MT, WA
- Investigation of the effect of deicing chemicals	NC, OR, FHWA
- Investigation of BMP	MD, OR, TN, WI, FHWA
- Investigation of potential impacts of highway culvert construction to the natural conditions of streams	AL, TX

Partial Summary of USGS National Activities

USGS WaterAlert

The USGS has continues to provide a very popular water-threshold exceedance notification program. The system sends email or text messages when water levels or water-quality conditions meet user-specified criteria. Criteria can include greater-than, less-than, within, and out-of-range thresholds. Reporting frequencies can include once-per-event, once-per-day, or once-per-hour messaging while the condition lasts. In 2012, the process was started to link subscribers with the USGS Flood Inundation Mapping Program Map Viewer (http://wim.usgs.gov/FIMI/) to help users select high-flow thresholds of interest. These maps, where available, along with NWS E-19 information sets provide locations and descriptions of local features such as roads or structures in the vicinity of streamgages and river stages that affect those features. The USGS WaterAlert system can be accessed at *http://water.usgs.gov/wateralert/*.

A complimentary interactive USGS query and alert feature called WaterNow is under development. This system will allow users to query any realtime USGS streamgage and request reports of the most recent measurement values for any data collected at the streamgage of interest. The query and response can be sent and received using any device with email and text message capabilities.

National Streamflow Information Program (NSIP)

This USGS program is an umbrella over all streamflow information activities of the USGS. The program has five major goals - (1) to maintain a stable streamgage network to provide federally needed streamflow information, (2) to provide better understanding of floods and droughts, (3) to perform periodic regional and national assessments of streamflow information, (4) to enhance the delivery of streamflow information and products, and (5) to develop and evaluate new technologies and methods for obtaining streamflow information.

NSIP was virtually flat funded in 2011. In FY 2012, program funding was increased by $2.5M to help stabilize the streamgage network. The NSIP is currently funded at about 24 percent of the design funding level.

The NSIP program description and list of proposed NSIP streamgages are on-line at http://water.usgs.gov/nsip/. Additional publications on the mission and goals of NSIP are on-line at http://water.usgs.gov/nsip/reports.html Also available on the NSIP web pages are internet links to real-time and historical streamflow data and information.

The National Water-Quality Monitoring Network

Another network effort has now taken form in response to recommendations of the Presidents Commission on Ocean Policy and the President's Ocean Action Plan. This is a coordinated effort led by the National Ocean and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), and the USGS working through the National Water Quality Monitoring Council (NWQMC) to develop an integrated system of long-term streamgages, water-quality and ecological monitoring sites with standardized monitoring techniques, parameters, and data-dissemination portals. The network will link elements of Federal, State, and local monitoring networks to reduce duplication and strengthen coverage. The network design focuses on water and ecological issues affecting coastal waters and ocean environments. The NWQMC report describing the network is available at http://acwi.gov/monitoring/network/index.html.

Updated Flood-Frequency Analysis Guidelines

Flood-frequency analysis provides information about the magnitude and frequency of selected flood discharges. Bulletin 17B of the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data (1982) defines procedures recommended to provide a consistent approach for determining flood-flow frequency from peak-flow records. The procedures include methods for improving skew estimates using regional skew information, tests for high and low outliers, adjustments for low outliers and zero flows, and methods for incorporating historic peak-flow information. In the near future, the Advisory Committee on Water Information, Subcommittee on Hydrology, Hydrologic Frequency Analysis Workgroup will consider a number of changes to the Bulletin 17B including the Expected Moments Algorithm (EMA) and a new multiple low outlier test based on a generalization of the Grubbs-Beck test. EMA is a highly efficient approach for capturing the information contained in historical flood data and other censored (incomplete) datasets.

The Peak flow FreQuency analysis program (PeakFQ) implements the Bulletin 17B recommended procedures for flood-frequency analysis of streamflow records. The program has been updated and now provides an interactive Windows interface to PeakFQ. Also the program can be run from a batch-style processing on DOS, UNIX and Linux operating systems. PeakFQ has been modified to include the EMA and the new multiple low outlier test.

Contact Tim Cohn (TACohn@USGS.gov) for more information about the USGS contributions to the effort.

Updated Flood-Frequency Regional Skew Map

The USGS is working with FEMA and various state and local agencies to update the National flood-frequency skew map now used in Bulletin 17B. Since the first map was published in 1976, some 35 years of additional streamflow information has accumulated, and better spatial estimation procedures have been developed (Stedinger and Griffis, 2008). A new statistical technique, Bayesian Generalized Least Squares (B-GLS) regression, is being used to calculate new regional skewness values. Thus far, this technique has been used in three studies: the Southeastern U.S. (South Carolina, North Carolina, and Georgia), California, and Iowa. Projects are underway in Missouri, Arizona, and Alaska. Instead of updating the map on a state-by-state basis, we would like to update the map on a multi-state, hydrologic basis with the eventual goal of updating the entire the maps for the entire Nation. Some states in the Missouri River Basin and New England have initiated efforts, but we have been unable to establish a coordinated effort.

Contact Andrea Veilleux (aveilleux@usgs.gov) if you have questions related to efforts related to updating the National flood-frequency skew map.

Contact Robert Mason (rrmason@usgs.gov) for general information about the flood-frequency program.

National Streamflow Statistics

The National Streamflow Statistics (NSS) Program is a Microsoft Windows-based computer program created by the USGS to estimate high and low streamflow statistics for ungaged sites across the United States. NSS provides estimates for low-flow duration and frequency estimates in addition to flood-frequency estimates such as the 100-year flood.

The NSS program has four components—a graphical user interface (GUI), an equation calculation routine, a database, and a help feature. The GUI allows users to control the operation of the software and presents results. The equation calculation routine computes streamflow statistics using basin and climatic characteristics entered by the user and provides tabling and graphing capabilities that graph frequency and hydrographs. The database contains all the information needed, such as the regression equations and standard errors, to solve more than 5,600 regression equations. The help facility contains the NSS Program User's manual, a link to the NSS program Web page, and version information.

Regression equations for estimating flood-frequency statistics of peak flows for rural and naturally flowing rivers are available for all 50 U.S. States including the Commonwealth of Puerto Rico and the island of Tutuila, American Samoa. State-specific regression equations for estimating flood-frequency statistics of peak flows for urban streams are available in NSS for 16 U.S. States. In addition, nationwide urban regression equations are available. Regression equations for estimating low-flow duration and (or) frequency are also currently available in NSS for 29 U.S. States. All equations contained in NSS were reviewed by USGS and were generally prepared in cooperation with state and local transportation, environmental, and/or water resource management agencies in each state.

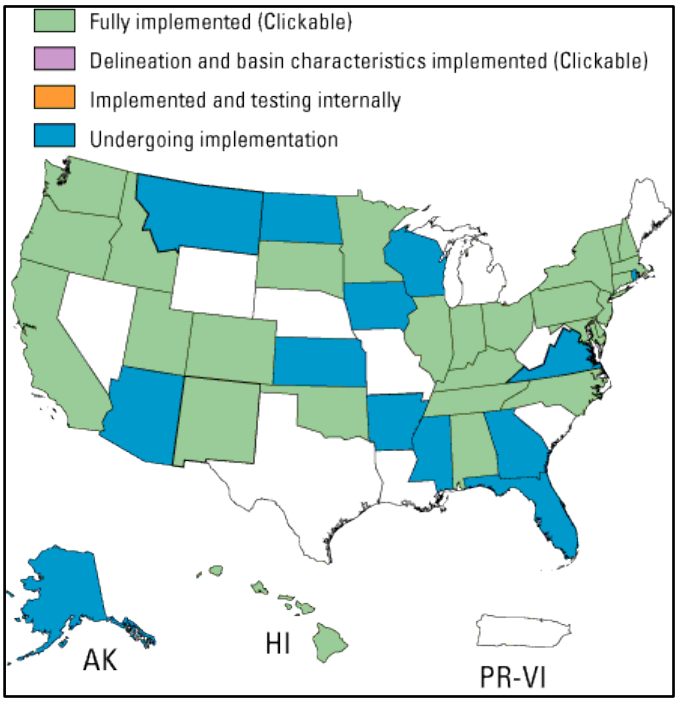
The NSS program and documentation can be downloaded from the Internet at: http://water.usgs.gov/software/NSS/.

A fact sheet that describes the NSS program was published in 2007 and can be downloaded at: http://pubs.usgs.gov/fs/2007/3010/.

If you should have questions regarding this information, please contact Todd Koenig (tkoenig@usgs.gov).

StreamStats Program

StreamStats (http://streamstats.usgs.gov) is a Geographic Information Systems-based Web application, developed by the U.S. Geological Survey (USGS) Office of Surface Water (OSW), which greatly reduces the time needed for users to obtain streamflow statistics, basin characteristics, and other information for USGS data-collection stations and for ungaged sites. This information is needed for use by engineers, land and water-resource managers, biologists, and many others to help guide decisions in their everyday work. Users can select data-collection station locations shown on a map interface in a Web browser window to obtain previously published information for the stations. Users also can select any location along a stream to obtain the drainage-basin boundary, basin and climatic characteristics, and estimated streamflow statistics for that location. The estimates for ungaged sites are determined from USGS regional-regression equations and usually can be obtained in only a few minutes.



(Accessed at http://water.usgs.gov/osw/streamstats/ssonline.html, November 21, 2012)

As of October 2012, StreamStats was available to the public for 27 states – Alabama (partial), California, Colorado, Connecticut, Delaware, Hawaii, Idaho, Illinois, Indiana, Kentucky, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New Mexico (partial), New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Dakota, Tennessee, Utah, Vermont, and Washington. In addition to the ability to delineate drainage basins and obtain estimates of streamflow statistics for user-selected ungaged sites, StreamStats also has the abilities to (1) navigate the stream network to locate upstream or downstream streamgaging stations, dams, point discharges and other water-related features and get information about those features, (2) estimate flows at ungaged sites based on the flows at nearby streamgaging stations, (3) change the basin characteristics for an ungaged site and obtain new estimates of flow statistics that reflect the changed basin characteristics, (4) obtain graphs of land-surface and stream-channel elevation profiles, (5) trace the path of a drop of water or a hazardous-waste spill from a point on the land surface to where it reaches a stream, and then downstream through the stream network, and (6) access StreamStats functionality from other Web or desktop GIS applications remotely by use of Web services. This functionality has not yet been fully implemented for all states. In addition, Maryland StreamStats allows users to obtain summaries of water use activities within the drainage basins for user-selected sites.

Plans for fiscal year 2012 include state-wide implementation of Alabama, Arkansas, Arizona, Iowa, Mississippi, Montana, North Dakota, Rhode Island, and Wisconsin. In addition, basin-wide applications are in preparation for the Connecticut and Delaware River Basins. These basin-wide applications will be linked to spreadsheet applications that will allow the estimation of time series of daily mean flows for ungaged sites. Updates to regression equations and/or supporting GIS datasets will be made to the applications for Hawaii, Kentucky, Maryland, Ohio, Oregon, Pennsylvania, Utah, and Washington.

Evaluation and Update of the Federal Highway Administration (FHWA) Pollutant Loadings Model for Highway Stormwater Runoff

The purpose of the project is to develop and implement a new version of the FHWA water quality model. The U.S. Geological Survey (USGS) in cooperation with the FHWA has developed a new model the Stochastic Empirical, Loading and Dilution Model (SELDM). SELDM uses available data and stochastic Monte Carlo methods to generate planning-level estimates of event mean concentrations (EMCs), discharges, and loads from the highway (or another land use) and in the receiving waters upstream of the highway-runoff outfall. These values are then used to calculate the EMCs, discharges, and loads downstream of the highway-runoff outfall using mass balance methods.

These estimates can be used to evaluate highway-runoff discharges as a potential source of water-quality constituents, the potential effects of runoff loads on receiving-water quality, and the potential effectiveness of Best Management Practices (BMPs) for reducing the effects of highway runoff on receiving waters. Statistics for streamflow, precipitation, runoff coefficients, highway water quality and upstream water quality are needed to develop planning level estimates for use with SELDM. The USGS developed a series of reports and (associated) computer programs to provide planning level estimates of stormflow and water quality and to refine such estimates with local or site-specific data. Currently, the model is being published and training courses for the model are being developed. Information is available on the website http://webdmamrl.er.usgs.gov/g1/FHWA/SELDM.htm

SELDM Model Publications:

Granato, G.E., in press, Stochastic Empirical, Loading and Dilution Model (SELDM) Version 1.0.0: Techniques and Methods of the U.S. Geological Survey, book 4, chap. C3, 31 p. with CD-ROM (The FHWA reference number is FHWA-HEP-09-006)

Granato, G.E., 2010, Methods for development of planning-level estimates of stormflow at unmonitored stream sites in the conterminous United States: FHWA-HEP-09-005, 90 p. with CD-ROM

Granato, G.E., 2009, Computer programs for obtaining and analyzing daily mean streamflow data from the U.S. Geological Survey National Water Information System Web Site: U.S. Geological Survey Open-File Report 2008–1362, 123 p. with CD-ROM

Granato, G.E., and Cazenas, P.A., 2009, Highway-Runoff Database (HRDB Version 1.0)--A data warehouse and preprocessor for the stochastic empirical loading and dilution model: Washington, D.C., U.S. Department of Transportation, Federal Highway Administration, FHWA-HEP-09-004, 57 p. with CD-ROM

Granato, G.E., Carlson, C.S., and Sniderman, B.S., 2009, Methods for development of planning-level stream-water-quality estimates at unmonitored sites in the conterminous United States: Washington, D.C., U.S. Department of Transportation, Federal Highway Administration, FHWA-HEP-09-003, 53 p. with CD-ROM

Granato, G.E., 2006, Kendall-Theil Robust Line (KTRLine--version 1.0)—A visual basic program for calculating and graphing robust nonparametric estimates of linear-regression coefficients between two continuous variables: Techniques and Methods of the U.S. Geological Survey, book 4, chap. A7, 31 p. with CD-ROM

National Synthesis on Potential Sources, Fate and Transport, and Potential Effects of Chloride in Surface- and Ground-Water Resources of the Conterminous United States

The Chloride (Cl) ion is receiving increasing attention as population growth makes increasing demands on available water resources and anthropogenic activities increase solute loads in natural waters. Cl is a growing concern because anthropogenic inputs may increase Cl concentrations to the USEPA's 250 mg/L taste criterion for potable waters, the 230 mg/L chronic criterion for aquatic life, or the 860 mg/L acute criterion for aquatic life. The Cl ion is ubiquitous in natural waters, has a wide variety of sources, readily moves through surface and ground waters, and is difficult to remove from runoff and water supplies. This national synthesis is a cooperative effort between the USGS and Federal Highway Administration designed to provide the information necessary for watershed managers to assess all potential sources of Cl in a given watershed as part of a total water and solute budget. This will include information necessary to develop a localized water budget; to develop water-quality transport curves; to estimate natural, agricultural, and anthropogenic sources of Cl; to examine interrelationships among water-quality constituents; and to use the National Water Information System Web to identify and interpret available groundwater, surface-water and water-quality data. This effort also will provide a summary of field methods including geophysical techniques and automated monitoring of runoff, streamflow, and ground water. Of 275 reports that have been complied, about 165 reports have been cataloged and reviewed. Water-quality transport curves for dissolved chloride have been developed for 84 USEPA Nutrient Ecoregions.

Web pages

The project web page: http://webdmamrl.er.usgs.gov/g1/FHWA/Cl.htm.

Deicing bibliography: http://webdmamrl.er.usgs.gov/g1/FHWA/qw/salt.htm

Performance metrics of low-impact development (LID) methods and other structural best management practices (BMPs) for reducing the effect of runoff from linear transportation projects

This project will provide information and statistics that can be used to calculate potential benefits of LID and conventional BMPs using the Stochastic Empirical Loading and Dilution Model (SELDM). SELDM is designed to provide a generalized stochastic representation of BMP treatment mechanisms. BMP treatment mechanisms included in SELDM are flow reduction, hydrograph extension, and water-quality modification. These performance criteria may represent the net effect of one structural BMP or a treatment train of several structural and nonstructural BMPs. This project will provide statistics that will be entered into SELDM so that highway engineers can test different BMPs in a simple point and click environment. This project also will provide a BMP estimator tool to calculate statistics that are necessary for use with SELDM so that highway engineers and scientists can easily update the selections in SELDM as new data become available.

Publications:

Granato, G.E., 2012, Estimating basin lagtime and hydrograph-timing indexes used to characterize stormflows for runoff-quality analysis: U.S. Geological Survey Scientific Investigations Report 2012–5110, 47 p.

Partial Summary of USGS Water Science Center Activities of Interest to State Highway Agencies

To obtain more detailed information about state-based activities from a USGS Water Science Center, visit http://water.usgs.gov/ and select a state from “Water Science by State”.

Alabama

- Hydrologic and Hydraulic investigations at various bridge sites in Alabama (including crest-stage gage data collection effort for urban streams.
- Culvert Impacts Study: A study to look at the impacts that culvert construction has on geomorphology, sediment concentrations in streams during storm events, turbidity, and benthic invertebrate populations. The study is set up to look at three phases - before, during, and 2-year post construction.

Recent Publications

Hedgecock, T.S., and Lee, K.G., 2010, Magnitude and frequency of floods for urban streams in Alabama, 2007: U.S. Geological Survey Scientific Investigations Report 2010–5012, 17 p.

Lee, K.G., and Hedgecock, T.S., 2010, Flood-depth frequency relations for rural streams in Alabama, 2003: U.S. Geological Survey Scientific Investigations Report 2010–5066, 25 p.

Alaska

- One project with Alaska Department of Transportation and Public Facilities (ADOT&PF) is related to channel migration in the Copper River Delta used a multi-dimensional flow model to:
    - Evaluate water-surface elevation along Mile 40 - 45 of the Copper River Highway for a 2 percent recurrence flood. The ADOT&PF is considering raising the grade and removing culverts along this stretch of the highway in order to restore a clear water stream to its original condition.
    - Evaluate diversion channels away from Bridge 339 of the Copper River Highway in order to protect the structural integrity of the bridge.
- A second program with ADOT&PF focuses on streambed scour monitoring and modeling had these accomplishments in 2012:
    - Extensive bathymetric and hydraulic survey at Bridge 339 of the Copper River Highway. Data are being used by the USGS to develop a multi-dimensional flow model for design of a replacement bridge.

    - Field surveys at 22 bridges with unknown foundations. Data are being used to evaluate streambed scour at these sites and identify locations where accurate foundation information is required to address the risk from streambed scour
    - Monitored pier scour at 20 sites around Alaska in near real time.
- Collected discharge measurements and channel surveys at scour-critical bridges during flooding in southcentral Alaska in September 2012.

Recent Publications

Conaway, J.S., and Schauer, P.V., 2012, Evaluation of streambed scour at bridges over tidal waterways in Alaska: U.S. Geological Survey Scientific Investigations Report 2012-5245, 38 p.

Brabets, T.P., 2012, Hydrology and Modeling of Flow Conditions at Bridge 339 and Mile 38-43, Copper River Highway, Alaska: U.S. Geological Survey Scientific Investigations Report 2012-5153, 26 p.

Conaway, J.S., and Brabets, T.P., 2011, Streamflow and streambed scour in 2010 at bridge 339, Copper River, Alaska, *in* Dumoulin, J.A., and Dusel-Bacon, C., eds., Studies by the U.S. Geological Survey in Alaska, 2010: U.S. Geological Survey Professional Paper 1784-C, 24 p.

Conaway, J.S., 2011, and Knapp, M.W., Development and execution of emergency monitoring at a scour-critical bridge, *in* Proceedings of the 2011 National Hydrologic Warning Council Conference, May 9-12, 20011, San Diego, California, 1 p.

Arizona

- In Arizona, the existing regional regression equations used for estimating magnitude and frequency of floods were developed using peak-flow from streamflow records and watershed data through 1986. Since then, 25 years of additional peak-flow data have been collected and advanced geographical information system (GIS) data and tools are available for identifying watershed characteristics related to flood hydrology in Arizona.
- The AzWSC is in the final year of a project that includes the implementation of StreamStats and the updating of flood frequency relations for Arizona. In addition to flood frequencies, flood volume probabilities will be determined for selected sites. The project is in cooperation with Maricopa County and other counties throughout the state. Project completion is anticipated in September 2012.

Arkansas

- A cooperative effort between seven agencies in Arkansas to implement StreamStats is underway. The Arkansas State Highway and Transportation Department is one of the seven agencies that are helping support this effort. StreamStats is expected to be fully implemented in Arkansas in December 2012.

California

- Flood frequency estimates for select rural "natural flow" (not substantially affected by regulation or diversions) streams throughout California have been updated. The estimates are based on greatly expanded data and documented in three reports available online.
    - The first report, published in 2011 and prepared in cooperation with the Federal Emergency Management Agency, the U.S. Army Corps of Engineers, and the U.S. Forest Service, provides a new regional equation to help characterize peak flows throughout California by using historical and recent flood data with updated statistical methodologies to calculate flood magnitude and frequency. This regional equation, based on data from 158 streamgages through 2005, takes into account elevation and the complex interaction of rain, snow and flood hydrology of California mountains on the frequency and magnitude of large floods. Using this new regional equation, the report also provides updated flood estimates for streams monitored by USGS streamgages primarily in the Sacramento-San Joaquin River basin.

- Building on the regional equation established in the aforementioned report, the second report develops new statewide prediction equations for determining the magnitude and frequency of annual instantaneous peak flows using data from 630 streamgages outside the southeastern California desert region. The report provides estimates of the annual exceedance probability flood flows - the probability of a certain size flood being equaled or exceeded in a given year - at 771 locations. Together, these two reports replace previous prediction equations that were last updated more than 30 years ago. These data and equations will be implemented into California StreamStats (http://water.usgs.gov/osw/streamstats/california.html) and also into the National Streamflow Statistics Program (http://water.usgs.gov/software/NSS/).
- The third report, prepared in cooperation with the U.S. Army Corps of Engineers, focuses on sustained flood flow (flood duration), which is needed to assess the adequacy of reservoirs, levees and other flood-control structures. Using data through 2008, the report examines annual maximum floods for 1-day, 3-day, 7-day, 15-day and 30-day durations at 50 dams and streamgages throughout the Sacramento-San Joaquin River basin and adjacent regions. Applying updated statistical methodologies to these data, the report provides new regional skew equations to help characterize flood-duration flows.

- Planned studies include the proposal of a low-flow study and/or development of regional equations for duration flows.

Recent Publications

Parrett, C., Veilleux, A., Stedinger, J.R., Barth, N.A., Knifong, D.L., and Ferris, J.C., 2011, Regional skew for California, and flood frequency for selected sites in the Sacramento–San Joaquin River Basin, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2010–5260, 94 p.

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles, 2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p., 1 pl.

Lamontagne, J.R., Stedinger, J.R., Berenbrock, Charles, Veilleux, A.G., Ferris, J.C., and Knifong, D.L., 2012, Development of regional skews for selected flood durations for the Central Valley Region, California, based on data through water year 2008: U.S. Geological Survey Scientific Investigations Report 2012–5130, 60 p.

Colorado

- The Colorado Water Science Center (CWSC), in cooperation with the Colorado Department of Transportation (CDOT), completed in FY12 a project which created a Web-based flood database for Colorado. The database uses an ARCGIS map interface to facilitate easy access of USGS data including indirect discharge measurements published in USGS Water Supply Papers and Water-Data Reports; indirect discharge measurements stored in USGS offices; paleoflood measurements published in peer-reviewed journal articles; and the peak flood of record at all USGS gages in Colorado from the USGS National Water Information System. CDOT is interested in this information so that engineers involved in road and bridge design can consider all flood related data that have been collected for a particular location or basin. Real flood data can now be used in addition to flood frequency estimates computed using the StreamStats program. The database will also provide an efficient storage and retrieval system for the future data. The database provides one location for documenting and storing USGS indirect measurements. The scope of work for this project included only USGS data. However, the CWSC and CDOT are planning to ask other state and federal agencies to have their data added to the database. This additional work would be covered under a separate project. In FY13, a USGS Open-File Report documenting the Colorado Flood Database, it tools, and the data sources will be published and the database will be publically available on the Web. Also, funding has been obtained to allow for the Colorado Flood Database to be updated in FY13 so the flood information in the flood database in current through FY12. Currently, the CWSC is working to obtain a funding mechanism that will allow the Colorado Flood Database to be updated annually and maintained into the future. The Colorado Flood Database could serve as a national template for the USGS to serve flood data over the internet similar to the way that StreamStats provides the results of USGS peak-flow and low-flow regression equations on a statewide basis.

Connecticut

- Investigated the effects of road salting on stream quality along a stretch of I-95 as part of an environmental impact study of a proposed plan to widen the highway. An Open File report summarizing the first year of data collection was completed January 2011.
- Field work began in the winter of 2009 on 4 streams with monitoring sites upstream and downstream of the highway. Monitoring included continuous conductance, temperature, and pH at all 8 sites plus continuous streamflow monitoring at downstream sites. Information from one site, Latimer Brook, is available in real time on the web. Discrete samples for chloride were collected frequently during runoff events following application of road de-icing chemicals, and samples for major ions were collected periodically. Data collection was completed September 30, 2011. Data analysis and final report will be completed in FY2013.

Recent Publications

Brown, C.J., Mullaney, J.R., Morrison, J., Mondazzi, R., 2011, Preliminary assessment of chloride concentrations, loads, and yields in selected watersheds along the Interstate 95 corridor, southeastern, Connecticut, 2008-09: U.S. Geological Survey Open-File Report 2011-1018, 41 p.

Delaware

- No highway related projects at this time.
- Discussions of a real-time monitoring project designed to provide early warning of flood-inundation for key evacuation routes are ongoing.

District of Columbia

- No highway related projects at this time.
- USGS Priority Ecosystems Science (PES) funded establishment and operation of two new data-collection sites to provide near-real time stream discharge and selected water-quality parameters to characterize the typical water-quality effects on Chesapeake Bay from watersheds exhibiting defined land use development patterns.

Florida

- During fiscal year 2012 the Florida Water Science Center continued a baseline monitoring project in collaboration with the Florida DOT to better understand the current hydrologic setting of the Cecil Webb and Yucca Pens managed areas. The hydrology of these two areas has been altered by recent development that includes the corridor of Interstate Highway 75 (I-75). The project includes the construction and surveying of 16 Staff and Crest Stage Gages to monitor water level peaks within managed areas, 2 real-time stage stations, and 2 tidal flow/salinity/temperature stations within Charlotte Harbor Preserve State Park, one also recording rainfall and air temperature data.

Georgia

- The USGS in cooperation with the Georgia Department of Transportation and Georgia Environmental Protection Division is in the process of implementing StreamStats for Georgia. StreamStats is expected to be fully implemented in Georgia in September 2014.
- Maintain a statewide network of 60 crest-stage gages as part of an ongoing flood-frequency study.

Recent Publications

Gotvald, A.J and Knaak, A.E., 2011, Magnitude and frequency of floods for urban and small rural streams in Georgia, 2008: U.S. Geological Survey Open-File Report 2011-5042, 39 p.

Hawaii

- Operates a network of 65 crest-stage gages to monitor peak stages and discharges at or near highway crossings on the islands of Kaua`i, Oahu, Moloka`i, Maui, and Hawai`i. The peak-flow data collected at these stations adds significantly to peak-flow data collected at continuous stations and improves regional coverage of peak-flow measurements in Hawai`i.
- Monitors rainfall, streamflow, and daily suspended-sediment concentration and load in North Halawa Stream to study impacts in the H-3 freeway corridor and receiving water bodies.
- Operates 20 real-time rain gages and 55 real-time streamflow monitoring stations on the islands of Kaua`i, Oahu, Moloka`i, Maui, and Hawai`i. Data from these gages are used to aid in flood warning and flood forecasting.

Idaho

- The Idaho Transportation Department uses the Idaho StreamStats web site extensively in the design of their Idaho Bridge Watch program (an early-warning bridge scour monitoring program based on the Q25 and Q50) as well as for other transportation-related design projects. The Idaho StreamStats website is at http://water.usgs.gov/osw/streamstats/idaho.html
- The BLM wishes to define minimum streamflows or streamflow statistics needed to maintain outstanding remarkable values within stream segments designated “Wild & Scenic” in southwest Idaho. The water right proposal is intended to protect the rivers in the study area from future development and excessive water demands. Unfortunately, the study area currently lacks sufficient streamflow data, and streamflow statistics obtained from the U.S. Geological Survey StreamStats program are imprecise for this purpose. The USGS Idaho Water Science Center is collecting short-term streamflow data at selected locations and indexing those stations to streamflow data collected at long-term streamgages to produce exceedance probability distributions and synthetic streamflow records.
- The Idaho Water Science Center is collecting streamflow, sediment, bathymetry, and videography data from the Kootenai River in Northern Idaho in support of the Kootenai River Habitat Restoration Program being conducted by the Kootenai Tribe of Idaho to restore listed Kootenai White Sturgeon. The information that the USGS is providing will be used to guide project remediation design and to evaluate changes resulting from remedial efforts. A multidimensional hydraulic flow model was developed for the spawning reach of the Kootenai River and will continue to be calibrated and used as a tool to predict changes to the channel morphology following remedial modifications.

Illinois

- **Pier and Contraction Scour in Cohesive Soils**—In Straub, T.D., and Over, T.M., 2010, Pier and Contraction Scour Prediction in Cohesive Soils at Selected Bridges in Illinois: Illinois Center for Transportation Report FHWA-ICT-10-074, 119 p. http://ict.illinois.edu/Publications/report%20files/FHWA-ICT-10-074.pdf, the results of testing the Scour Rate In Cohesive Soils-Erosion Function Apparatus (SRICOS-EFA) method for estimating scour depth of cohesive soils at 15 bridges in Illinois were presented. In the current study, a component of the SRICOS-EFA method, which includes the calculation of the maximum contraction and pier scour, known as Zmax, is further tested for 15 additional bridge sites. The sites meet geotechnical criteria for cohesive soils, and are to be modeled with scour depths calculated using SRICOS Zmax, HEC-18 and the Illinois DOT cohesive soil reduction-factor method. The results are being compared to measured scour data. The hydraulic parameters for the Zmax calculation are obtained from HEC-RAS/HEC-18. The soil parameter (critical shear stress) is from the relationship published in the 2010 report, which requires input of a laboratory-determined compressive soil strength, Qu. An evaluation of the relation of laboratory with field Qu values has been completed to develop a correlation to allow field Qu values to be used to provide the critical shear stress. The approximate historic peak flow will be determined for each site, and the historic scour hole will be measured using Ground Penetrating Radar or seismic technologies to compare with modeled results. The final report is to be published in 2013.
- **Urban Flood Frequency**--The USGS Illinois Water Science Center, in cooperation with the U.S. Army Corps of Engineers-Chicago District, has investigated the effects of urban developments on peak streamflows. The objective is to adjust peak-flow data in urbanized northeastern Illinois to a stationary series consistent with current land-use conditions, to be used for urban flood-frequency analysis. The historical data has been adjusted by using causative factors including precipitation, land-uses (at applicable scales and affecting runoff generation), and reservoirs (at applicable large scales and affecting channel routing) as the explanatory variables for adjusting past historical records to the 2006 NLCD land-use conditions. The report is currently under review. The next phase of the study will develop regional equations for urbanized basins, and implement these results in StreamStats. Funding is being sought from State and federal cooperators, including the Illinois Center for Transportation.
- **Manning's Roughness Coefficients for Illinois Streams**-- Manning's roughness coefficients for 43 natural and constructed streams in Illinois are reported and displayed on a U.S. Geological Survey Web site. At a majority of the sites, discharge and stage were measured and corresponding Manning's coefficients—the *n*-values—were determined at more than one river discharge. The *n*-values discussed in this report are computed from data representing the stream reach studied and, therefore, are reachwise values. Presentation of the resulting *n*-values takes a visual-comparison approach similar to the previously published Barnes report (1967), in which photographs of channel conditions, description of the site, and the resulting *n*-values are organized for each site. The Web site where the data can be accessed and are displayed is at URL *http://il.water.usgs.gov/proj/nvalues/*. This project was in cooperation with the Illinois Department of Natural Resources—Office of Water Resources.

Recent Publications

Soong, David T., Prater, Crystal D., Halfar, Teresa M., and Wobig, Loren A., 2012, Manning's roughness coefficient for Illinois streams: U.S. Geological Survey Data Series 668, 14 p.

Indiana

- In 2012 the USGS operated 26 streamgages in cooperation with the Indiana DOT.
- Flood inundation map libraries for 7 USGS streamgage sites and collocated NWS flood forecast points, to assist with highway, road, and bridge operations during floods. One library was published in 2012 and an additional 4 were completed pending technical or USGS approving official review. All are scheduled to be complete by the end of 2013.

- The USGS is participating in an Indiana Silver Jackets Hazard Mitigation Taskforce Fluvial Erosion Hazard (FEH) project. This multi-year project, started in 2011 and continued through 2012, is providing science-based tools for the use of federal, state, and local agencies in mitigation of hazards caused by riverine erosion. Tools include regional curves for use in assessing stream stability and a bridge screening tool that can be used to assess the erosion potential at bridge sites. A key stakeholder group for use of FEH products is transportation officials.

Iowa

- Cooperatively funds 21 continuous-record gaging stations.
- Cooperatively funds 89 crest-stage gages.
- Cooperatively funds ongoing flood-profiles project to document water-surface profiles of significant flood events. Two reports were published in 2012:
    - Eash, D.A., 2012, Floods of July 23-26, 2010, in the Little Maquoketa River and Maquoketa River Basins, Northeast Iowa: U.S. Geological Survey Open-File Report 2011–1301, 45 p. with appendix
    - Barnes, K.K., and Eash, D.A., 2012, Flood of August 11-16, 2010, in the South Skunk River Basin, Central and Southeast Iowa: U.S. Geological Survey Open-File Report 2012–1202, 27 p. with appendix.
- Iowa StreamStats—A 2006-2013 investigation to develop a comprehensive flood-estimation method for unregulated, rural streams in Iowa. Specific objectives are to: (1) Implement an interactive StreamStats Web site for Iowa that allows users to easily select stream sites and estimate flood-frequency discharges by automating the measurement of basin characteristics and calculation of regression estimates. (2) Develop two sets of regional regression equations, one set for basins with drainage areas less than 50-100 square miles and another set for basins with drainage areas greater than 10-50 square miles, to estimate flood-frequency discharges. (3) Define the same hydrologic regions for both sets of regional regression equations, unless, the definition of a separate set of hydrologic regions for each set of small- and large-basin regression equations provides a significant improvement in the overall predictive accuracy of both sets of regression equations. (4) Develop the smallest drainage-area range for a transition zone as possible for Iowa to prevent the possibility of small-basin regression estimates exceeding large-basin regression estimates. During 2012, final EMA flood-probability analyses were computed for 516 streamgages included in the peak-flow study. Final regression equations were developed for each of the eight flood probabilities for each of the three peak-flow regions defined for Iowa. A total of 24 regression equations were developed for the State. A single regression line was fit to each peak-flow region, instead of two regression lines for small and large drainage areas as originally proposed for the study, because use of a power transform optimization program for drainage area provided a good fit to the data for two of the three regions and a log-transform of the data provided a good fit for the third region. Average standard errors of prediction are lower for 20 of the 24 new regression equations compared to the 2001 report equations. A report documenting the Iowa peak-flow estimation study has been prepared and is currently receiving a peer review.

Kansas

- The Kansas Water Science Center streamflow statistics project has provided improved estimates versus the ungaged regression equations for 5,427 stream segments for flood frequency and various duration flows.
- The Kansas StreamStats is on the web at http://ks.water.usgs.gov/Kansas/studies/strmstats/.
- The Kansas Water Science Center operated 28 crest-stage gages in small drainage basins, some urban and some rural, for use in future flood frequency determinations. Annual peaks for 2011 were compiled and published in the USGS Peak Flow File.

Kentucky

- No highway related projects at this time.

Louisiana

- A cooperative program with the Louisiana Department of Transportation and Development (LA DOTD) to operate 10 continuous real-time streamflow data collection stations, 13 real-time stage stations, 17 non-recording crest-stage gages, and 7 non-recording flood-profile gages.
- **Analysis of Flood Magnitude and Frequency in Louisiana:** Streamflow statistics are used by government agencies, engineers, scientists, and environmental groups for the purpose of water management, permitting, and design. The primary source of streamflow data are streamgages operated by the USGS. The magnitude and frequency for floods are primary in considering bridge design. The USGS proposes update flood frequency statistic at gaging stations, and provide updated regression equations to estimate flood frequency at ungaged sites.
- **Water Use in Louisiana:** Historical and current water-use data are essential for analysis of water allocations, environmental effects, and future development of our water resources. State and local governments, private industries, and Federal Agencies use water-use data in Ground-Water modeling, Water-Use projections, and in assessments of water resources in a particular area. Collection of these data provides up-to-date information for major water users throughout Louisiana and promotes improved reporting, quality, and accuracy of data provided by these facilities.
- **Simulation of Ground-Water Flow in the "1,500-Foot" and "2,000-Foot" Sands and Movement of Saltwater in the "2,000-Foot" Sand of the Baton Rouge Area, Louisiana:** Saltwater encroachment has been detected in six aquifers, including the "1,500-ft" and "2,000-ft" sands, north of the Baton Rouge fault in East Baton Rouge Parish. The encroachment is in response to groundwater withdrawals, primarily for public supply and industrial uses, in Baton Rouge. Additional information is needed for water planners and managers in the Baton Rouge area to make decisions on future management of ground-water resources in the area. The impact of the pumping wells on ground-water flow and the northward encroachment of saltwater are not well known. The time and route for saltwater to travel from the fault to pumping centers is not known. The need for and possible locations of additional pumping wells, injection wells, or observation wells is not known. A computer model has been proposed to simulate past, current, and a variety of possible future conditions in the "1,500-foot" and "2,000-foot" sands. Such a model would pro-vide a tool to water planners and managers to evaluate possible management alternatives, and in-crease the understanding of saltwater movement in aquifers in similar hydrogeologic settings.
- **Development and maintenance of a computer model to simulate groundwater flow and saltwater encroachment in the Baton Rouge Sands:** Ten aquifers beneath the Baton Rouge area are used for freshwater supplies and are variably impacted by water-level declines and/or saltwater encroachment. Long-term water-level declines have occurred in most of these aquifers and saltwater encroachment has been detected. The USGS proposes to update, modify, and calibrate the computer model to accurately simulate groundwater conditions in all 10 Baton Rouge sands. The model would provide a tool for water planners and managers to assess the impacts of pumpage changes on all the aquifers.
- **Trends in Groundwater levels and Stream discharge in Louisiana, 2000- 2010:** Louisiana has abundant supplies of fresh ground-water and surface-water. However, increasing withdrawals of water and subsequent affects are a concern to public officials. Knowledge of water-level and surface-water discharge trends will help water managers optimize ground-water and surface-water resources.
- **Potentiometric Maps of the “200-,” “500-,” and “700-Foot” Sands of the Lake Charles area in Southwestern Louisiana:** In the Calcasieu and Cameron Parishes, the Chicot aquifer system consists of the “200-,” “500-,” and “700-foot” sands of the lake Charles area, which are the principal sources of fresh groundwater in the parishes. The declines of groundwater levels produce gradients favorable for saltwater encroachment towards the Lake Charles area. Observation wells have indicated a northward progressive movement of the freshwater-saltwater interface. The objective is to document current (2012) water levels and water-level trends in the aforementioned aquifers, and determine the general direction of ground-water flow in these aquifers.

- **Potentiometric Surface, 2010, and Water-Level Changes from 2007 to 2012 in the Sparta Aquifer in Northcentral Louisiana:** The potentiometric surface of the Sparta aquifer in Louisiana was last documented in 2007. A current (2012) potentiometric map is needed to document water levels and water-level changes in the aquifer since 2007. Area with water-level declines will be documented, and pumping center identified.

Maine

- **Evaluating the use of field indicators for computing design streamflows for small ungaged streams in Maine—**The USGS, in cooperation with MaineDOT, is testing the feasibility and accuracy of methods to estimate streamflows for ungaged streams in Maine, using easy-to-measure field indicators in the vicinity of the site of interest, including culvert rust lines and channel geomorphology. In 2012, field reconnaissance and data collection were completed for streams in Maine with historical data and basin areas less than 20 mi^2.
- **Impact of future peak-flow stationarity on bridge design—**The USGS, in cooperation with MaineDOT, has projected potential future annual peak streamflows for 4 basins in coastal Maine, using the Precipitation-Runoff Modeling System (PRMS) and temperature and precipitation changes that bracket likely future changes. Projected design peak flows for selected annual exceedance probabilities were computed, based on projected annual peak flows, and compared to design peak flows based on modeled historical flows. Modeled historical flows were compared to observed historical flows. The report is currently at technical peer review.
- **Method for computing a wide range of flows, from very low to very high flows; suitable for estimating flow-duration curves at ungaged locations in Maine--**Data for candidate explanatory variables have been gathered, including geologic, meteorological, topographic, and land-use data. Variable flow statistics at USGS streamflow gages are being derived on annual and monthly bases; spanning a wide range of exceedance probabilities (e.g. 0.01, 0.05, 0.10, 0.25, 0.50, 0.75, 0.90, 0.95, 0.99). Derived regression equations will be published in a USGS Scientific Investigations Report. Not only will these regression equations provide managers and engineers with more complete flow information at ungaged locations, they provide the means for estimating flow duration curves at ungaged locations. With this ability, it paves the way for the development of more sophisticated methods for flow estimation at ungaged locations.
- **Small-watershed data collection—**Peak-flow data collection (crest-stage gages) continues on 12 streams, all with basins less than one square mile. Nine sites have 12 complete years of data collection, three sites have 11 complete years of data collection, and two have less than 8 years of data. In addition, ten seasonal rain gages have been installed to prepare for a future time-of-concentration study. Five basins were selected for rain gages and two rain gages have been installed in each of two basins; one rain gage near the flow monitoring point and the other in the headwaters of the basin.
- **Continuous streamflow data collection—**Continuous data collection continues at 18 USGS streamflow gages and one tide gage.

Recent Publications

Schalk, C.W., and Stasulis, N.W., 2012, Relations among water levels, specific conductance, and fracture depths in four road-salt contaminated wells in Maine, 2007–9: U.S. Geological Survey Scientific Investigations Report 2012–5205.

Maryland

- The USGS Eastern Geographic Science Center has conducted studies of Best Management Practices (BMPs) in the Chesapeake Bay watershed. Urban and suburban development is associated with elevated nutrients, sediment, and other pollutants in stormwater runoff, impacting the physical and environmental health of area streams and downstream water bodies such as the Chesapeake Bay. Stormwater management facilities, also known as BMPs, are increasingly being used in urban areas to replace services, such as flood protection and water quality improvement, originally performed by wetlands and riparian areas. Scientists from the USGS have partnered with local, academic, and other Federal agency scientists to better understand the effectiveness of different stormwater management strategies (i.e., the use of centralized or decentralized systems) with respect to local stream and Chesapeake Bay health. Improving our understanding of how stormwater management actions may best mitigate urban development could help protect the environmental health of downstream water bodies that ultimately receive runoff from urban landscapes.
- Fourteen streamgages were operated cooperatively with the Maryland State Highway Administration (MDSHA).
- StreamStats coverage has been expanded to include the entire State of Maryland by way of an ongoing (non-MDSHA, Non-FHA) project. Through an informal collaboration with MDSHA (and that agency's support of the Maryland Hydrology Panel) new peak-flow frequency estimation equations developed by Dr. Glenn Moglen and Mr. Will Thomas will be served for the State of Maryland using the StreamStats application. Certain existing low-flow prediction equations are not currently active due to an inability to reproduce watershed characteristic and low-flow estimates from existing prediction equations in the Eastern Shore and Western regions of Maryland that are consistent with previously-published results. Development of new low-flow estimation methods is under consideration for the affected areas.

Recent Publications

Loperfido, J. V., Hogan, Dianna M., 2012, Effects of Urban Stormwater-Management Strategies on Stream-Water Quantity and Quality; Fact Sheet 2012-3079.

Massachusetts

- **Evaluation and Update of the Federal Highway Administration (FHWA) Pollutant Loadings Model for Highway Stormwater Runoff:** The purpose of the project is to develop and implement a new version of the FHWA water quality model. The U.S. Geological Survey (USGS) in cooperation with the FHWA has developed a new model the Stochastic Empirical, Loading and Dilution Model (SELDM). SELDM uses available data and stochastic Monte Carlo methods to generate planning-level estimates of event mean concentrations (EMCs), discharges, and loads from the highway (or another land use) and in the receiving waters upstream of the highway-runoff outfall. These values are then used to calculate the EMCs, discharges, and loads downstream of the highway-runoff outfall using mass balance methods.

  These estimates can be used to evaluate highway-runoff discharges as a potential source of water-quality constituents, the potential effects of runoff loads on receiving-water quality, and the potential effectiveness of Best Management Practices (BMPs) for reducing the effects of highway runoff on receiving waters. Statistics for streamflow, precipitation, runoff coefficients, highway water quality and upstream water quality are needed to develop planning level estimates for use with SELDM. The USGS developed a series of reports and (associated) computer programs to provide planning level estimates of stormflow and water quality and to refine such estimates with local or site-specific data. Currently, the model is being published and training courses for the model are being developed. Information is available on the website: http://webdmamrl.er.usgs.gov/g1/FHWA/SELDM.htm

- **National Synthesis on Potential Sources, Fate and Transport, and Potential Effects of Chloride in Surface- and Ground-Water Resources of the Conterminous United States (**http://webdmamrl.er.usgs.gov/g1/FHWA/Cl.htm**):** The Chloride (Cl) ion is receiving increasing attention as population growth makes increasing demands on available water resources and anthropogenic activities increase solute loads in natural waters. Cl is a growing concern because anthropogenic inputs may increase Cl concentrations to the USEPA's 250 mg/L taste criterion for potable waters, the 230 mg/L chronic criterion for aquatic life, or the 860 mg/L acute criterion for aquatic life. The Cl ion is ubiquitous in natural waters, has a wide variety of sources, readily moves through surface and ground waters, and is difficult to remove from runoff and water supplies. This national synthesis is a cooperative effort between the USGS and Federal Highway Administration designed to provide the information necessary for watershed managers to assess all potential sources of Cl in a given watershed as part of a total water and solute budget. This will include information necessary to develop a localized water budget; to develop water-quality transport curves; to estimate natural, agricultural, and anthropogenic sources of Cl; to examine interrelationships among water-quality constituents; and to use the National Water Information System Web to identify and interpret available groundwater, surface-water and water-quality data. This effort also will provide a summary of field methods including geophysical techniques and automated monitoring of runoff, streamflow, and ground water. Of 275 reports that have been complied, about 165 reports have been cataloged and reviewed (http://webdmamrl.er.usgs.gov/g1/FHWA/qw/salt.htm). Water-quality transport curves for dissolved chloride have been developed for 84 USEPA Nutrient Ecoregions.
- **Performance metrics of low-impact development (LID) methods and other structural best management practices (BMPs) for reducing the effect of runoff from linear transportation projects:** This project will provide information and statistics that can be used to calculate potential benefits of LID and conventional BMPs using the Stochastic Empirical Loading and Dilution Model (SELDM). SELDM is designed to provide a generalized stochastic representation of BMP treatment mechanisms. BMP treatment mechanisms included in SELDM are flow reduction, hydrograph extension, and water-quality modification. These performance criteria may represent the net effect of one structural BMP or a treatment train of several structural and nonstructural BMPs. This project will provide statistics that will be entered into SELDM so that highway engineers can test different BMPs in a simple point and click environment. This project also will provide a BMP estimator tool to calculate statistics that are necessary for use with SELDM so that highway engineers and scientists can easily update the selections in SELDM as new data become available.
- **Flood Frequency Analysis:** USGS currently has a proposal in at Massachusetts Department of Transportation to update the flood frequency equations.

Recent Publications

Granato, G.E., in press, Stochastic Empirical, Loading and Dilution Model (SELDM) Version 1.0.0: Techniques and Methods of the U.S. Geological Survey, book 4, chap. C3, 31 p. with CD-ROM (The FHWA reference number is FHWA-HEP-09-006)

Granato, G.E., 2010, Methods for development of planning-level estimates of stormflow at unmonitored stream sites in the conterminous United States: FHWA-HEP-09-005, 90 p. with CD-ROM

Granato, G.E., 2009, Computer programs for obtaining and analyzing daily mean streamflow data from the U.S. Geological Survey National Water Information System Web Site: U.S. Geological Survey Open-File Report 2008–1362, 123 p. with CD-ROM

Granato, G.E., and Cazenas, P.A., 2009, Highway-Runoff Database (HRDB Version 1.0)--A data warehouse and preprocessor for the stochastic empirical loading and dilution model: Washington, D.C., U.S. Department of Transportation, Federal Highway Administration, FHWA-HEP-09-004, 57 p. with CD-ROM

Granato, G.E., Carlson, C.S., and Sniderman, B.S., 2009, Methods for development of planning-level stream-water-quality estimates at unmonitored sites in the conterminous United States: Washington, D.C., U.S. Department of Transportation, Federal Highway Administration, FHWA-HEP-09-003, 53 p. with CD-ROM

Granato, G.E., 2006, Kendall-Theil Robust Line (KTRLine--version 1.0)—A visual basic program for calculating and graphing robust nonparametric estimates of linear-regression coefficients between two continuous variables: Techniques and Methods of the U.S. Geological Survey, book 4, chap. A7, 31 p. with CD-ROM

Granato, G.E., 2012, Estimating basin lagtime and hydrograph-timing indexes used to characterize stormflows for runoff-quality analysis: U.S. Geological Survey Scientific Investigations Report 2012–5110, 47 p.

Michigan

- A network of 9 streamgages and 5 crest-stage gages were operated in cooperation with Michigan Department of Transportation. In addition, 26 other crest-stage gages located at or near highway crossings provide peak stage and streamflow information that is available for local and state transportation agencies. Peak-flow data from the crest-stage gage network is also used to augment data collected at 142 additional continuous-recording streamgages operated in Michigan and enhances coverage of peak-flow measurements in the region.

Minnesota

- Operate a network of 77 crest-stage gages that record peak-flow at or near highway crossings. The peak-flow data collected at these stations augments data collected at the 155 continuous recording stations operated in Minnesota and enhances coverage of peak-flow measurements in the region.
- Methods used to estimate peak-flow at USGS gages in Minnesota 2011-2012--Project Objectives: Document methods used to compute peak-flow statistics for all USGS Minnesota Water Science Center peak-flow gaging stations. A web mapping application will display all high-flow gaging stations documented in the report, and provide a hyperlink to graphs, statistical tables, and period of record documentation. The first year of this project fiscal year 2011 will involve data collection, analysis, and documentation of all peak-flow stations. The web page and report will be completed by January 2013.
- StreamStats operation and maintenance for FY 12, also adding a “Zoom To” bridge location utility that will allow users of StreamStats to select a bridge from a list and zoom to that location.
- Provide hydraulic investigation support, and bridge scour monitoring as requested.
- The USGS is conducting a study in cooperation with FEMA to document the magnitude and extent of flooding in June 2012 in Northeastern Minnesota. The report presents the methods for collecting high-water mark data, producing flood-inundation maps, and assessing the flood frequency, as well as documenting the hydrologic conditions leading to the floods and a summary of the flood impacts. The report, “*Floods of June 2012 in Northeastern Minnesota*” by Christiana R. Czuba, James D. Fallon, and Erich W. Kessler, will be published online at the end of December 2012.
- The U. S. Geological Survey, in cooperation with the White Bear Lake Conservation District, Minnesota Pollution Control Agency and other state, county, municipal, and regional planning agencies, watershed organizations, and private organizations, conducted a one-year study to characterize groundwater and surface-water interactions in White Bear Lake and their effect on water levels in the lake. Between 2010 and 2011, White Bear Lake and other lakes in the northeastern portion of the Twin Cities metropolitan area were at historically low levels. Water samples were collected for major constituent and stable isotope analyses from White Bear Lake and other nearby lakes. Results from these analysis indicated that sodium and chloride concentrations were higher in surface water from small lakes that border roads that are heavily salted during the winter months. The application of road salt application is a likely explanation for the high sodium and chloride concentrations observed in the lakes. The Minnesota Department of Transportation has been concerned about the effects of road salting on water resources, and with lake levels in areas of Minnesota where there are lakes that are rising to the point of overtopping roads. The White Bear Lake study is in review and is expected to be published this winter.

- USGS is collecting sediment and streamflow data that are used by the Department of Natural Resources to validate statewide stream restoration directives. The DNR, Division of Ecological and Water Resources, uses HEC-RAS models to improve culvert designs at stream/road crossings in order to improve ecological function, water quality, and ensure channel and floodplain connectivity. Proper culvert design and placement is needed to ensure transport of water and sediment in such a manner that the stream is able to maintain its dimension, pattern, and profile over an extended time without either aggrading or degrading. HEC-RAS modeling is used to simulate transport of streamflow and sediment through bridges, culverts, piers, and dams. Validation of the model through measured streamflow and sediment data are critical to successful bridge and culvert designs, and when needed the restoration of damaged stream systems.

Recent Publications

Ellison, Christopher A.; Sanocki, Chris A.; Lorenz, David L.; Mitton, Gregory B.; Kruse, Gregory A., Floods of September 2010 in Southern Minnesota; 2011: U.S. Geological Survey Scientific Investigations Report 2011–5045, 37 p., 3 app.

Robert A. Blanchard, Christopher A. Ellison, Joel M. Galloway, and Dennis A. Evans, Sediment Concentrations, Loads, and Particle-Size Distributions in the Red River of the North and Selected Tributaries near Fargo, North Dakota, during the 2010 Spring High-Flow Event: U.S. Geological Survey Scientific Investigations Report 2011–5064, 27 p.

Lorenz, D.L., Sanocki, C.A., and Kocian, M.J., 2010, Techniques for estimating the magnitude and frequency of peak flows on small streams in Minnesota based on data through water year 2005: U.S. Geological Survey Scientific Investigations Report 2009–5250, 54 p.

Mississippi

- Continue to provide streamflow records, hydrologic analyses of basins, and hydraulic analyses of the flooding potential at selected stream crossings, known as bridge-site studies. Scour analyses are also conducted at selected sites.
- Continue to operate and maintain 98 crest-stage gages and 2 flood hydrograph gages
- Continue to operate a near real-time scour monitoring gage at a coastal bridge. Streambed soundings are obtained at this and other selected bridges to document scour.
- Continue to prepare an updated version of the 1991 flood-frequency reports to include the use of GIS determined basin characteristics for development of regional flood-frequency equations and the implementation of StreamStats. Plan to be completed in FY 2013.
- During September 2012, flagged and surveyed Hurricane Isaac riverine high-water marks in the State in cooperation with FEMA and data were provided to FEMA in October 2012.
- In late FY 2010, began a 3-year cooperative project with the City of Hattiesburg and other city, county, and State agencies to produce a digital library of flood-inundation maps to visually determine the areal extent of flooding corresponding to a NWS-forecasted Leaf River stage. The interactive inundation mapper is available at http://wim.usgs.gov/FIMI/

Recent Publications

Storm, J.B., 2012, Flood inundation mapping for the Leaf River at the city of Hattiesburg, MS [abs.]: Proceedings of the 2012 Mississippi Water Resources Conference, Jackson, Mississippi, April 3-4, 2012, p.129, available online at http://www.wrri.msstate.edu/pdf/2012_wrri_proceedings.pdf

Storm, J.B., 2012, Flood-inundation maps for the Leaf River at Hattiesburg, Mississippi: U.S. Geological Survey Scientific Investigations Map 3228, 8 p. pamphlet, 13 sheets

Wilson, K. Van, 2012, Sea level rise visualization and measurements of subsidence and accretion rates for the Alabama, Mississippi, and Florida coastlines [abs.]: Proceedings of the 2012 Mississippi Water Resources Conference, Jackson, Mississippi, April 3-4, 2012, p.133, available online at http://www.wrri.msstate.edu/pdf/2012_wrri_proceedings.pdf

Missouri

- Continued operation of a network of 38 crest-stage.
- Continued operation and maintenance of the statewide stream-gaging network, 7 of which are operated in cooperation with MoDOT.
- Continued operation of near-real-time scour monitors at Chariton River near Novinger, Missouri, and at both main channel piers of Missouri River at Jefferson City, Missouri.
- Publication of report of bathymetric surveys of Missouri River bridges using multibeam echo sounder during summer 2011 flooding: all the bridges on the Missouri River in Missouri except Rulo, NE (35 bridges at 27 sites)
- Ongoing bathymetric surveys at site of new bridge for US 59 over the Missouri River at Atchison, KS for Kansas DOT. One additional scan is planned after removal of construction trestle in late 2012 with report to follow.
- **Revision of rural regression equations for Missouri:** Existing regression equations for rural basins in Missouri are based on skew values derived from data through the 1973 water year. Since then 37 years of additional data has been collected to improve the accuracy of the skew map. The Bulletin 17B skew map does not distinguish between model and sampling errors in the data. Thus, it is likely that station skews are over weighted resulting in a bias in the final streamgage flood frequency analyses. Historical floods were primarily ignored in the 1995 study because of the limited methodology of treating censored data. An in-depth analysis of historical information and use of historical peaks is needed. Development of areal comparisons of peak runoff rates is also needed for historical floods. Results will be used to extend streamgage records. Bayesian Generalized Least Squares technique for regional skew analyses will be performed to develop more accurate skew(s) values for Missouri. Expected Moments Algorithm (EMA) released in November 2007 by the USGS will be used to analyze censored data more rigorously. Record extension improves the accuracy and reliability of at-site streamgage flood frequency analyses. Extending streamgage records where historical flood events have been recorded will result in much improved at-site flood frequency estimates. Revision of the skew map will improve the accuracy of at-site flood frequency estimates and resulting regional regression equations. The EMA technique improves the estimation of flood frequency discharges for streamgage records that include censored data such as historical events and less-than-value discharges. About 25 percent of the streamgages in Missouri have censored data.
- **Development of dimensionless unit hydrographs for urban areas in Missouri:** Streamflow data collected at streamgages inherently reflect unique characteristics of the basin upstream, such as peak magnitude, lag time, flow volume, and baseflow. These components can be defined for a basin and used to develop a unit hydrograph for the basin, which is the hydrograph that would result from a basin given a unit (1 inch) of rainfall excess over the basin. A unit hydrograph can be a useful part of the process of watershed modeling or design of stormwater-management structures. Flood hydrographs may be used to determine the water-surface elevation and duration of inundation at and upstream from roadways and drainage structures, as well as to estimate flood volumes for combined sewer systems. The primary objective of this study is to develop a new dimensionless unit hydrograph for urban basins in Missouri, using the recently-revised urban flood frequency equations and developing new regression equations to compute peak discharges (based on rainfall), unit hydrograph peak discharges, basin lag times, and storm volume based on selected basin and flow characteristics. These equations can be used to determine unit hydrographs and flood volumes at urban ungaged sites.

Recent Publications

Huizinga, R.J., 2012, Bathymetric and velocimetric surveys at highway bridges crossing the Missouri River in and into Missouri during summer flooding, July – August 2011: U.S. Geological Survey Scientific Investigations Report 2012–5204, 166 p.

Montana

- Bridge-scour data collection and analysis program ongoing since 1991. As part of this program, near real-time scour monitoring is being conducted at four sites.
- Small-stream peak-discharge data collection program ongoing since 1955 to assist with infrastructure design. Currently operating 86 crest-stage gages.
- Ongoing cooperative project to investigate the hydrology of selected wetland areas affected by proposed and recently constructed highway projects.
- Monitor scour and related hydraulic conditions at the I-90 bridge near the mouth of the Blackfoot River following the 2008 removal of Milltown Dam, which was located just downstream on the Clark Fork.
- Determine flood-frequency estimates and the impact of climate change for more than 660 USGS gaging stations in Montana based on data through water year 2011.

Nebraska

- The USGS Nebraska Water Science Center (NEWSC) documented changes in cross sections at selected bridges before, during, and after flooding events in cooperation with the Nebraska Department of Roads (NDOR). Cross-section data were retrieved from historic discharge measurements and compiled and presented in a database.
- NEWSC cooperated with the NDOR to conduct sequential bathymetric surveys of the Missouri River using a multi-beam echosounder at all 16 highway bridges along the Nebraska-Iowa/South Dakota/Missouri border to monitor the effects of scour on bridge infrastructure during the 2011 Missouri flood during FY11. The study continued into FY12.
- NEWSC conducted bathymetric surveys using a multi-beam echosounder of 14 pipelines crossing the Missouri River bordering Nebraska for the Pipeline Safety Hazardous Materials Administration, Department of Transportation, during the 2011 Missouri flood during FY11. The study continued into FY12.
- Several studies investigating the cumulative effects of human activities such as transportation infrastructure on the lower Platte River corridor ecosystem are being conducted in cooperation with local, state, and federal agencies. Techniques such as time-lapse photography, sediment sampling over time, and sediment transport modeling are being used to study impacts on geomorphology and habitat on river reaches at or near bridges.
- A proposal is being developed to update peak-flow frequency analyses for streamgages in Nebraska. This project would be the first step in a phased approach to implement StreamStats.

Nevada

- Maintain a Statewide network of crest-stage gages, 24 with the Nevada Department of Transportation and 4 with the US Army Corps of Engineers. Prepare a report describing flood frequencies at crest-stage gage locations to be published in FY13.
- USGS and Nevada Department of Transportation entered into an agreement in FY06 to compute sediment loads in the Clear Creek Drainage. This study will assess the impact of runoff from a U.S. Highway. The study is event driven where the sample collection intensifies during snowmelt and summer thunderstorms. A Scientific Information Report was published in FY09. A three-year agreement with the Nevada Department of Transportation to continue monitoring sediment and selected water quality constituents in the Clear Creek drainage was signed in October 2009. The report for the continuation of this project will be published in FY13. A new proposal is to be submitted to the Nevada Department of Transportation to extend the project through FY16.

New Hampshire

- New Hampshire Department of Transportation (NHDOT) funds approximately one-third of New Hampshire's stream-gaging network.

New Jersey

- A bridge scour data collection project was started in April 2008. The general objectives of this program are to monitor and validate the effects of scour at NJDOT bridge structures designated as scour critical and to obtain updated flow and velocity data. This is a long-term project with additional monitoring locations added this year. The monitoring work done in FY2012 includes:
    - Operate and maintain continuous-record discharge gaging stations at 11 locations to provide discharge data to improve models to calculate scour. Gage height and discharge data available in near real-time on our website http://nj.usgs.gov
    - Continuous monitoring of streambed elevations at selected locations near bridge piers and abutments at 2 sites. The effects of scour at these bridge sites will be evaluated by NJDOT by monitoring streambed elevations over time at selected locations. Streambed elevation is available in near real-time from our website http://waterdata.usgs.gov/nj/nwis/current/?type=bridge&group_key=basin_cd
    - Survey channel cross-sections at multiple locations upstream and downstream of the bridge at the gages and at bridges at an additional 20 sites to monitor changes in channel geometry over time.
    - A crest-stage gage is operated and maintained at 1 bridge to record peak stage and discharge.
- An acoustic Doppler current profiler is operated and maintained to record a continuous-record of velocity at one gaging station.

New Mexico

- **Flood Analysis**
    - Operate and maintain the New Mexico crest-stage gage network of 8 gages in ephemeral streams around the State. Fifty-two of the crest-stage gages in the network are currently equipped with automated pressure transducers.
    - Continued documentation of notable floods through collection of flood information such as high-water marks, peak stages and discharges by indirect measurements at miscellaneous flooded sites.
- **StreamStats**
    - New Mexico StreamStats development is partially funded through FY 2013 by the USGS in cooperation with the USDA (Forest Service, Southwestern Region) and the New Mexico Department of Transportation (NMDOT). Information about the StreamStats program can be found at: http://water.usgs.gov/osw/streamstats/new_mexico.html.
    - A New Mexico StreamStats pilot area (the portion of the San Juan Basin within New Mexico) is complete, tested, and available online (see web page link above). Coverage should be expanded to include the entire State of New Mexico by the end of FY13 using recently released NHD-Plus Version 2 data. Basic basin characteristics will be available at release and more advanced features could be added in the future.

New York

- Documented notable floods through collection of flood information such as peak stages and discharges at discontinued gages, flood profiles along flooded streams, and indirect flood discharge measurements at miscellaneous flooded sites.
- Maintained a statewide network of 40 crest-stage gages to determine annual peak flows.
- Implemented the use of GIS techniques to automate the computation of estimated flood frequency discharges at any unregulated stream location in New York using StreamStats.
- Worked with the State Emergency Management Office, NYSDOT, NYSGS, and others to develop a statewide landslide susceptibility mapping project. Schenectady County was completed in 2008, but continuation of the project is currently on-hold due to lack of funding.
- Monitored landslides in and around the Tully Valley, New York area.

Recent Publications

Mulvihill, C. I. and B. P. Baldigo, 2012. Optimizing bankfull discharge and hydraulic geometry relations for streams in New York State. Journal of the American Water Resources Association. v.48, pg 449-463.

Suro, T.P, Murray, P.M., and Lumia, R., In Preparation, Maximum Known Stages and Discharges of New York Streams and their Annual Exceedance Probabilities through September 2011.

North Carolina

- The USGS North Carolina Water Science Center (NCWSC) in cooperation with the North Carolina Department of Transportation (NCDOT) completed a project in spring 2012 to develop and implement the statewide USGS StreamStats application for North Carolina. A Factsheet documenting the statewide StreamStats application was approved for publication in early December 2012.
- The NCWSC provided support during 2012 to the USGS South Carolina Water Science Center (SCWSC) as part of an on-going urban flood-frequency study being conducted by the SCWSC. The NCWSC reviewed peak-flow files for urban continuous-record gaging stations and updated at-site flood-frequency (FF) statistics based on the Bulletin 17B procedures. The at-site FF statistics were provided for 44 sites. All sites with exception of one (USGS Sta. 02093229 at Wilmington) are located in the Piedmont region: 10 in the Raleigh area, 8 in Greensboro, 1 historical site in Winston-Salem, and 24 sites in the Charlotte area. The FF statistics for the NC sites will be combined with sites from adjacent or nearby states to develop techniques for estimating urban FF statistics at ungaged sites. The SCWSC study is scheduled to be completed by December 2013.
- The NCWSC continues to collect data in order to establish baseline bed-sediment chemistry and water-quality conditions and the associated circulation dynamics of Currituck Sound in Northeastern North Carolina in the vicinity of the planned alignment of the proposed Mid-Currituck Bridge. These data will be used to evaluate the environmental effects associated with the bridge construction and bridge deck stormwater runoff on Currituck Sound in the second phase of the study. As a result of delays in bridge construction, sampling to establish baseline conditions has been extended to cover a 26-month period leading up to the planned start of bridge construction. Samples are being analyzed for a wide range of constituents that are both informative and applicable to the receiving waters and are mainly those analytes that were identified as parameters of concern in the recently completed study that characterized bridge deck stormwater runoff across North Carolina (Wagner and others, 2011). The analytes being sampled for include metals, nutrients, pH, suspended solids, polycyclic aromatic hydrocarbons (PAHs) and other organic compounds.
- Continued to operate continuous streamflow gaging stations on Goose Creek at Fairview, NC (USGS Sta. 02124692) and Waxhaw Creek near Jackson, NC (USGS Sta. 02147126) just outside of Charlotte in cooperation with the NCDOT.

Recent Publications

Wagner, C.R., Fitzgerald, S.A., Sherrell, R.D., Harned, D.A., Staub, E.L., Pointer, B.H., and Wehmeyer, L.L., 2011, Characterization of stormwater runoff from bridges in North Carolina and the effects of bridge deck runoff on receiving streams: U.S. Geological Survey Scientific Investigations Report 2011–5180, 95 p. + 8 appendix tables.

Weaver, J.C., Terziotti, Silvia, Kolb, K.R., and Wagner, C.R., 2012, StreamStats in North Carolina – A water-resources Web application: U.S. Geological Survey Fact Sheet 2012-3137, 4 p.

North Dakota

- The Upper Missouri River regularly received annual peak flows above 100,000 cubic feet per second prior to the completion of the Garrison Dam. Annual peak flows consistently have been between 30,000 and 45,000 cfs following dam completion. The largest flood since dam regulation occurred in 2011 following an abnormally high snow pack season and a week-long rain event in the headwaters. The dam releases have had a discernible impact on the Missouri River throughout this section.

  The 2011 flood has highlighted the critical need for quantifying the complex interaction between the regional geomorphology and human activities. It is necessary to first understand and quantify the historical impacts of the dams in order to determine the impact of the 2011 flood on the channel configuration, morphology, and sediment dynamics.

  A study by the USGS was initiated in 2012 to: (1) determine channel trajectory following dam closure and subsequent dam operation to provide a baseline for flood studies; (2) determine flood impacts on islands, sand bars, and infrastructure; (3) predict channel change through time around the Bismarck-Mandan area through numerical modeling; (4) assess the post-flood delta for potential ice jam issues and quantify reservoir sedimentation; (5) determine the sources, sinks, and loads of sediment throughout the free-flowing reach; and (6) determine flood impacts on in-channel and floodplain large woody debris and standing trees for island maintenance, sediment balance, fisheries, and navigation interests.

  The study is being conducted in cooperation with U.S. Army Corps of Engineers, ND State Water Commission, ND Department of Health, ND Game and Fish Department, ND Department of Transportation, Burleigh County WRB, Morton County WRB, Lower Heart River WRB, City of Bismarck, and the City of Mandan.

Ohio

- A network of 18 crest-stage gages was operated in cooperation with the Ohio DOT and the Ohio Department of Natural Resources. The crest-stage gage data will be used to augment existing flood-frequency information available for Ohio.
- The U.S. Geological Survey (USGS) Ohio Water Science Center and a coalition of seven partner agencies (including the Ohio DOT) recently finished developing a state-of-the-art advanced flood-warning system for about 40 stream miles in Licking County, Ohio. The objectives of the work were to (1) enhance the flood-forecasting ability of NWS by reestablishing a previously discontinued streamgage, upgrading an existing lake-level gage, and installing new streamgages, (2) develop static flood-inundation boundaries for a range of stages along selected reaches of four streams that will be linked to NWS flood forecasts and served on the NWS Advanced Hydrologic Prediction Service (AHPS) Web pages, (3) facilitate advanced flood warning to the area of Buckeye Lake and Interstate 70 by developing an unsteady-flow hydraulic model to be used by the NWS in conjunction with NWS forecast flows, and (4) publish a report detailing the methods used in and results from development of the system. The report on the study was released in September 2012.

Recent Publications:

Ostheimer, C.J., 2012, Development of a flood-warning system and flood-inundation mapping in Licking County, Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5137, 13 p., 39 pl.

Oklahoma

- StreamStats is fully operational and public availability occurred in 2011.

Recent Publications:

Smith, S.J., and Esralew, R.A., 2010, StreamStats in Oklahoma-- Drainage-basin characteristics and peak-flow frequency statistics for ungaged streams: U.S. Geological Survey Scientific Investigations Report 2009-5255, 58 p.

Lewis, J.M., 2010, Methods for Estimating the Magnitude and Frequency of Peak Streamflows for Unregulated Streams in Oklahoma: U.S. Geological Survey Scientific Investigations Report SIR 2010-5137, 41 p.

Oregon

- **SELDM** – In FY2012 ORWSC began a two-year coop study with the Oregon Department of Transportation (ODOT) to implement the Stochastic Empirical Loading and Dilution Model (SELDM) in Oregon. SELDM will be used to estimate combinations of contaminant loads and concentrations from upstream basins and highway runoff affecting the water quality of receiving streams (Granato, in press). Specific objectives of the ORWSC study are to: 1) Develop and refine local precipitation and hydrologic geospatial data layers needed for SELDM, 2) Install precipitation and hydrologic geospatial data layers into the Oregon StreamStats site, 3) Develop and compile upstream basin and highway water-quality transport curves and data sets for Oregon applications, and 4) Evaluate the impacts of storm water runoff on downstream water quality at five Oregon highway sites using SELDM and Best Management Practices (BMP).
- **StreamStats** – Currently the Oregon StreamStats site includes equations for estimating 2-, 5-, 10-, 25-, 50-, 100-, and 500-year flood frequencies in western Oregon (Cooper, 2005). For the entire state, StreamStats can also compute basin characteristics needed to estimate low-flow frequency (7Q2, 7Q10) and flow duration (5^{th}, 10^{th}, 25^{th}, 50^{th}, and 95^{th}) statistics from equations currently installed in the NSS program (Risley and others, 2008). StreamStats will soon have the capability of computing those low-frequency and flow duration statistics automatically.

Recent Publications:

Cooper, R.M., 2005, Estimation of peak discharges for rural, unregulated streams in western Oregon: U.S. Geological Survey Scientific Investigations Report 2005-5116, 134 p.

Granato, G.E., in press, Stochastic Empirical, Loading and Dilution Model (SELDM) Version 1.0.0: Techniques and Methods of the U.S. Geological Survey, book 4, chap. C3, 31 p. with CD-ROM (The FHWA reference number is FHWA-HEP-09-006)

Risley, J., Stonewall, A., and Haluska, T., 2008, Estimating flow-duration and low-flow frequency statistics for unregulated streams in Oregon: U.S. Geological Survey Scientific Investigations Report 2008-5126, 22 p.

Pennsylvania

- **StreamStats—** The current application of StreamStats for Pennsylvania is located at http://water.usgs.gov/osw/streamstats/pennsylvania.html. StreamStats for Pennsylvania can be used to estimate the following flow statistics:
    - Low-flows: 7-day, 10-year; 7-day, 2-year; 30-day, 10-year; 30-day, 2-year; 90-day, 10-year
    - Base-flows: 10-year, 25-year, and 50-year recurrence intervals
    - Mean flows: including the harmonic mean and mean annual flow
    - Flood-flows: 2- year, 5- year, 10- year, 50- year, 100- year, and 500-year recurrence intervals.
- In FY2012, new basin characteristics were added to StreamStats, including longitude, mean maximum daily temperature, drainage runoff number, and percent impervious area.
- **Flood inundation mapping—**Development of flood inundation maps for selected water-surface elevations at National Weather Service (NWS) flood forecast points in the Susquehanna River basin. The study on the West Branch Susquehanna River at Lewisburg and Milton, Pa. is in the final stages of completion and will be completed in 2013. The final inundation maps for Lewisburg and Milton will be displayed on the NWS Advanced Hydrologic Prediction Service web site (AHPS), the USGS Flood Inundation Mapper (FIMI), http://wim.usgs.gov/FIMI/ and on the Susquehanna River Basin Commission Inundation Mapping Viewer (SimV) (http://maps.srbc.net/). A project to create inundation maps of the Harrisburg Area was started in 2012 and will be completed in 2013. The Harrisburg inundation maps also will be displayed on AHPS, FIMI, and SimV.

- **Storm Surge Sensor Deployments—**The Pennsylvania Water Science Center deployed 6 storm surge sensors in the Delaware Bay to document storm surge in the Bay due to Hurricane Sandy. Water-level data were collected during the event and elevation data were collected after the event and displayed on the USGS Hurricane Sandy Storm Tide mapper within a week of the event. http://54.243.149.253/home/webmap/viewer.html?webmap=c07fae08c20c4117bdb8e92e3239837e
- **Streamgages—** A cooperative network of peak-flow and continuous-record streamgages is operated statewide to provide real-time and historical stage and streamflow data to support real-time flood-warning and forecasting efforts. Streamflow data collected from streamgages in the network will also be used in the development of streamflow statistics to describe and predict low-flow and peak-flow conditions. These streamflow statistics are critical to the design of structures in, over, and near waterways. Stations located within the Pennsylvania network and the data collected at each streamgage can be viewed at http://waterdata.usgs.gov/pa/nwis/rt.

Recent Publications

Stuckey, M.H., Koerkle, E.H., and Ulrich, J.E., 2012, Estimation of baseline daily mean streamflows for ungaged locations on Pennsylvania streams, water years 1960–2008: U.S. Geological Survey Scientific Investigations Report 2012–5142, 61 p.

Puerto Rico

- No activity or projects to report.

Rhode Island

- No highway related projects at this time.

South Carolina

- Operate 7 continuous-record gaging stations and 48 partial-record crest-stage stations. (Number of gaging stations fluctuates slightly from year to year.)
- **Evaluation of recently developed NCHRP abutment-scour equations** -The U.S. Geological survey (USGS) in cooperation with the National Cooperative Highway Research Program (NCHRP) has begun an investigation to evaluate the performance of recently developed abutment-scour equations (NCHRP Projects 24-15(2) and 24-20) using 324 field measurements of abutment scour collected in South Carolina (Benedict, 2003), Maine (Lombard and Hodgkins, 2008), and the USGS National Bridge Scour Database (NBSD; http://water.usgs.gov/osw/techniques/bs/BSDMS/index.html, accessed December 11, 2012; Wagner and others, 2006). Results from the analysis will identify performance characteristics for each scour-prediction method and will help formulate application guidance. The project started in October 2012 and will be completed January 2015
- **Modification of selected South Carolina bridge-scour envelope curves -** The USGS and the South Carolina Department of Transportation (SCDOT) began (2010) a cooperative effort to test the application of the South Carolina bridge-scour envelope curves at selected bridges in South Carolina with unknown foundations. During the initial phase of that investigation, it became apparent that the clear-water abutment-scour and live-bed contraction-scour envelope curves, developed in previous investigations, could be modified to include a family of curves. This modification would provide a refined assessment of the upper limit of observed historic scour depths in South Carolina, in particular for sites associated with smaller drainage areas. A review of the patterns in laboratory and field data for abutment and contraction scour led to the formulation of conceptual models for developing the modified envelope curves. Application of the conceptual models to the South Carolina field data and limited data from other locations in the United States produced a family of curves that can be used to assess the potential for clear-water abutment and live-bed contraction scour at bridges in the Piedmont and Coastal Plain of South Carolina. This project was completed in 2012 and a report documenting this investigation has been published.

- **Application of South Carolina envelope curves to selected bridges in South Carolina -**The Federal Highway Administration has begun an initiative to encourage states to determine the characteristics of bridge foundations over waterways that are currently classified as having unknown foundations. The South Carolina Department of Transportation (SCDOT) has initiated an investigation to estimate foundations at approximately 600 bridges with unknown foundations. Once the foundation characteristics have been defined, the SCDOT will need to evaluate the bridges for scour vulnerability. The USGS has developed regional bridge-scour envelope curves for each component of scour based on three field investigations of historic scour in South Carolina. The bridge-scour envelope curves can be used to help assess the potential for scour at selected bridges without the need for a detailed hydraulic model. This investigation developed a protocol and template for applying the South Carolina bridge-scour envelope curves to bridges with unknown foundations, and tested the template at approximately 80 bridge sites assigned by the SCDOT. The project started in late FY2010 and was completed in FY2012.
- **Development of a manual to integrate previous bridge scour field investigation findings -**The USGS, in cooperation with the SCDOT, conducted a series of three field investigations of bridge scour (Benedict, 2003; Benedict and Caldwell, 2006; Benedict and Caldwell, 2009) with the goal of collecting historic scour measurements in order to better understand regional trends of scour within South Carolina. The new investigation will conduct additional research on the field data and use previous and new findings to develop an integrated procedure for applying the South Carolina bridge-scour envelope curves to help assess scour potential at riverine bridges in South Carolina. The project started in December 2012 and will be completed January 2016
- **Urban flood-frequency investigation -** Urbanization can produce significant changes in the flood-frequency characteristics of streams; consequently, rural basin flood-frequency relations are typically not applicable to urban streams. Updates and improvements of South Carolina's highway infrastructure at stream crossings require an ongoing understanding of flood characteristics especially for urban watersheds. In addition, urban planners and engineers need current information for establishing flood-insurance rates and other water-resource management decisions. One of the tools necessary for such management are techniques that allow for the estimation of the magnitude and frequency of floods at sites on urban streams where gaged data are not available.

  In May 2010, the USGS South Carolina Water Science Center began a cooperative investigation with the SCDOT to update urban flood-frequency estimates in South Carolina. The specific objectives of the investigation are to: (1) update the magnitude and frequencies of peak-flows at urban stations, (2) update basin characteristics for the urban stations using consistent geographical information system methods, and (3) update the regional urban-flood-frequency equations for the 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent chance exceedance flows. Similar to the rural flood-frequency investigation which was completed in 2009, the urban investigation will include urban stations from South Carolina, North Carolina, and Georgia. In addition, the urban study will include stations from the inner Coastal Plain of New Jersey. The inclusion of urban stations from New Jersey will allow for a substantial expansion of the drainage area size for which the Coastal Plain flood-frequency regression equations will be applicable. The project is ongoing and is expected to be completed by December 2013.

- **Characterization of storm runoff from selected SCDOT Maintenance Yards -**The SCDOT operates maintenance yards throughout the State. Prior to this investigation, the SCDOT had no data to define the quality of stormwater leaving these sites. To provide these data, the USGS, in cooperation with the SCDOT, began a 4-year investigation in October 2009 to identify and quantify constituents that are transported in stormwater runoff from two maintenance yards and a section shed. The two maintenance yards, located in North Charleston and Conway, S.C., represent facilities where equipment and road maintenance materials are stored and that conduct complete equipment repair operations. The section shed, located in Ballentine, S.C., (about 15 miles west of Columbia, S.C.) is a facility that stores equipment and road maintenance material. Water-quality samples, rainfall data, and flow measurements of stormwater runoff were collected at these sites to date. The water-quality samples were analyzed for selected constituents including suspended sediment, total suspended solids, turbidity, total organic carbon, biochemical oxygen demand, selected metals, nutrients, oil and grease, and polyaromatic hydrocarbons. A USGS Scientific Investigations report is currently being written and the planned publication date is October 2013. In addition to identifying and quantifying constituents that are transported in stormwater runoff from SCDOT maintenance facilities, the information collected in this investigation also may be used by the SCDOT in the development of stormwater management plans and to address future, potential National Pollutant Discharge Elimination System (NPDES) permit requirements to characterize and mitigate stormwater quality at these sites.

Recent Publications

Benedict, S.T., and Caldwell, A.W., 2012, Modification of selected South Carolina bridge-scour envelope curves: U.S. Geological Survey Scientific Investigations Report 2012-5029, 37 p.

South Dakota

- Operate a network of about 50 crest-stage gages for the purpose of peak-flow analysis.
- Implementation of StreamStats in South Dakota was initiated in 2005 and was subsequently extended to allow incorporation of high-resolution topographic data that have since been completed. A separate project (with different cooperators) to develop a 6th level Hydrologic Unit Map for South Dakota also was completed and serves as another cornerstone for StreamStats digital base layers. The project is very close to completion and limited public availability of the StreamStats application was achieved late in 2011. Several problems were encountered with implementation of the application for determination of basin characteristics and have been undergoing evaluation and resolution throughout the year. Full-scale implementation is anticipated early in 2013.
- A study was completed during 2011 that used paleoflood hydrology techniques to improve peak-flow frequency estimates for several major drainages in the Black Hills of western South Dakota (Harden and others, 2011). This area was devastated by catastrophic flash flooding during 1972 that caused at least 238 deaths and was a primary impetus for the study. The study approach primarily involved extrapolation of peak-flow records through stratigraphic analysis and age dating of flood slack-water deposits, which were used to develop chronologies of very large flood events that pre-date observed peak-flow records. The study provided clear geologic evidence of multiple floods as large and even larger than those of 1972 during recent millennia within the study area. A short fact sheet (Driscoll and others, 2012) that provides a lay-reader summary of study results was published during 2012 was widely distributed as part of activities commemorating the 1972 floods.

  A new paleoflood study phase for the southern part of the Black Hills area was recently initiated in cooperation with the SDDOT Office of Research. It is anticipated that field investigations will be initiated during 2013 and will be ongoing for several subsequent years.
- SDDOT and USGS also have been collaborating for several years on a project involving analysis of potential bridge scour for sites along local government roads. Field work for this project was completed this summer and results will be included in a completion report that is planned for publication during 2013.

Recent Publications

Harden, T.M., O'Connor, J.E., Driscoll, D.G., and Stamm, J.F., 2011, Flood-frequency analyses from paleoflood investigations for Spring, Rapid, Boxelder, and Elk Creeks, Black Hills, western South Dakota: U.S. Geological Survey Scientific Investigations Report 2011–5131, 136 p.

Driscoll, D.G., Huft, D.L., and O'Connor, J.E., 2012, Extreme floods in the Black Hills area—New insights from recent research: Pierre, S. Dak., South Dakota Department of Transportation, 4 p. http://www.sddot.com/business/research/projects/docs/SD2008-01_Fact_Sheet_06-11-12.pdf

Tennessee

- Providing hydraulic interpretative support and miscellaneous flood-measurement support to Tennessee Department of Transportation (TDOT) as needed.
- Operating an ongoing network of 60 crest-stage gages at or near highway crossings and operating another 12 stage-discharge gages across the state for the purpose of flood-frequency analysis and general resource evaluation.
- Routinely updating basin characteristics files and statewide flood-frequency equations for ungaged streams in Tennessee. Our most recent update was based on the region-of-influence statistical model and was completed in FY 2003.
- Large-scale study of the effects of highway construction on stream ecology throughout Tennessee—looking specifically at sediment export from disturbed areas, the efficiency of sediment control structures (EPSCs) at construction sites, sediment transport processes, the effects of sediment on downstream habitat and biotic communities, and improved methods for monitoring sediment-related effects. This work began in FY2004 and will continue through FY2014.
- Refining GIS coverages and enhancing tools and analytical protocols for the Tennessee StreamStats page (http://water.usgs.gov/osw/streamstats/tennessee.html). This page was completed and released in 2007.
- Developing and applying GIS techniques to identify karst features on a regional scale and producing a GIS karst dataset for Tennessee. The dataset of karst features will span the eastern 2/3 of Tennessee classified as karst and will include closed depressions and their watersheds. The GIS techniques will be applied to the highest-resolution and most accurate digital elevation datasets available for Tennessee. This work began in FY2009 and will continue through FY2014.

Texas

- **Measurement File Data Mining and Regionalization** (FY10--13, ongoing project): The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Texas Tech University (Ted Cleveland), University of Houston (Kyle Strom), and University of Texas at San Antonio (Hatim Sharif and Xiaofeng Liu) in a project funded by the Texas Department of Transportation to investigate the approximately 90,000 entries for 427 stations of discharge, top width, area, and mean velocity for the streamflow measurement database in Texas. The purpose of this research is to develop tools (equations) to generalize the relation between mean velocity and a given discharge along with hydraulic, watershed, and channel properties to help guide TxDOT designers in analysis and review of hydraulic models. Another purpose is to generalized the relation between discharge and hydraulic, watershed, and channel properties. For the former, an equation such as Vbar=a * (Qdesign)^b * (TopWidth)^c * (OtherStuff)^(etc) could be forthcoming and in the latter, an equation such as Q=a * (CrossArea)^b * (TopWidth)^c * (ChannelClassification)^d * (OtherStuff)^(etc). Very preliminary statistical analysis suggests that with cross-section area, top width, and mean annual precipitation that near 0.25log10 error in discharge estimation might be possible and hence useful in a variety of investigative and interpretative settings.
- **Rational Method Assessment** (FY08--10): Completed: The SW research group with the Texas Water Science Center in a peer-to-peer research consortium with Texas Tech University (Ted Cleveland, David Thompson) and Auburn University (Xing Fang) has completed a project funded by the Texas Department of Transportation to investigate the rational method for small to moderately sized rural and urban watersheds in Texas.

- **Staggered-Barrel Culvert Research (FY10--12, terminated):** The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Texas Tech University and University of Houston in a project funded by the Texas Department of Transportation to investigate whether staggered culvert barrel inlets, inlets with overlapping crowns and inverts, can be arranged to maintain gravel and similar bed-material transport through the system by frequent storm events. The project will largely be executed by physical modeling at the Texas Tech University Hydraulics lab. As of this writing, special provisions to the capR software described in the following section have been made. Further, a cohort of students at Texas Tech University under direction of Dr. Cleveland and Dr. Asquith with considerable collaboration with Kyle Strom at University of Houston have digitally recovered about 12,000 records of flume data from the literature that include conventional measures such as discharge, sediment charge, froude number, and grain size. The research group has contributed to the physical modeling of culverts and sediment transport at the hydraulics laboratory at Texas Tech University. The laboratory experiments were completed in summary 2011. The final report is in progress as led by University colleagues.
- **Small Watershed Gaging Program** (FY06--12 and on-going): The Texas Department of Transportation and the USGS returned for FY06--10 (five-year increment) to small watershed data collection through a cooperative program. The program was recently extended into FY11--15. A network of about 50 crest-stage gages for flood-peak recording on small watersheds in western Texas. About ten of these gages will have autonomous stage recording and rainfall for production of rainfall and runoff data sets to drive the TxDOT research program in future decades. About three of the gages with also be operated as continuous real-time (conventional gages). An emergent contribution to hydraulic computations from this project is the development of an R-based implementation "capR" of the FORTRAN-based USGS-Culvert Analysis Program (CAP). Numerous extensions have been made. We have a functional tool that can readily process time series of contemporaneous headwater and tailwater conditions. To date, we have computed discharge for about 350 peaks.

Recent Publications

Asquith, W.H., Herrmann, G.R., and Cleveland, T.G., in press, Generalized additive regression models of discharge and mean velocity generally associated with direct-runoff conditions in Texas---The Utility of the U.S. Geological Survey discharge measurement database: [in ASCE Journal of Hydrologic Engineering production department, 10.1061/(ASCE)HE.1943-5584.0000635]

Asquith, W.H., in press, Regression models of discharge and mean velocity associated with median-streamflow conditions from a U.S. Geological Survey discharge measurement database in Texas: [in ASCE Journal of Hydrologic Engineering production department, 10.1061/(ASCE)HE.1943-5584.0000715]

Asquith, W.H., 2011, A proposed unified rational method for Texas in Cleveland, T.G., Fang, X., and Thompson, D.B., 2011, Use of the rational and modified rational methods for TxDOT hydraulic design: Texas Department of Transportation Research Report 0--6070--1, section 3, pp. 18--58.

Asquith, W.H., Cleveland, T.G., and Roussel, M.C., 2011, A method for estimating peak and time of peak streamflow from excess rainfall for 10- to 640-acre watersheds in the Houston, Texas, metropolitan area: U.S. Geological Survey Scientific Investigations Report 2011--5104, 38 p.

Cleveland, T.G., Fang, X., and Thompson, D.B., 2011, Use of the rational and modified rational methods for TxDOT hydraulic design: Texas Department of Transportation Research Report 0--6070--1, 143 p.

Dhakal, N., Fang, Xing, Cleveland, T.G., Thompson, D.B., Asquith, W.H., Marzen, L.J., 2012, Estimation of runoff coefficients for Texas watersheds using land-use and rainfall-runoff data: accepted by ASCE Journal of Irrigation and Drainage, v.~138, no.~1, pp.~43--54, doi:10.1061/(ASCE)IR.1943-4774.0000368.

Dhakal, N., Fang, X., Asquith, W.H., Cleveland, T.G., Thompson, D.B., 2012, Rate-based estimation of the rational runoff coefficients for selected watersheds in Texas: [in ASCE Journal of Hydrologic Engineering, doi:10.1061/(ASCE)HE.1943-5584.0000753]

Dhakal, N., Fang, X., Asquith, W.H., Cleveland, T.G., Thompson, D.B., in press, Return period adjustments for runoff coefficients: [in ASCE Journal of Irrigation and Drainage Engineering production department]

Harwell, G.R., Asquith, W.H., 2011, Annual peak streamflow and ancillary data for small watersheds in central and western Texas: U.S. Geological Survey Fact Sheet 2011-3082, 4 p.

Asquith, W.H., in press, Parameter Estimation for the 4-parameter asymmetric exponential power distribution by the method of L-moments using R: [in Computational Statistics and Data Analysis production department]

Utah

- The Colorado River Salinity Control Forum has cooperatively funded research to investigate the effects of public lands motor vehicle "play" areas on sediment transport, by both wind and water in south-central Utah. The research area is adjacent to state highway 24 and the Fremont river in the vicinity of Factory Butte. This project is a multi-discipline effort between water, biology, and geology and is currently in the data collection phase. Four crest stage gages are being operated on culverts that pass under highway 24 and event samplers have been installed in tributaries to the Freemont. The project has also paid for the operation and maintenance of the Freemont nr Cainville (09330230) stream gage and real time temperature and conductance probe through April 2012.

Vermont

- Vermont Agency of Transportation (VTrans) is currently funding a network of 28 crest-stage gages located in small headwater watersheds throughout the state.
- VTrans funds approximately one-third of Vermont's stream-gaging network.

Virginia

- A network of 17 crest-stage gages are operated in coordination with the Virginia Department of Transportation (VDOT) to determine annual peak flows, document extreme flow events, and improve flood frequency estimates.
- A cooperative study between VDOT and USGS began in Fiscal Year 2011 to develop analytical tools and equations to estimate peak flows specific to urban areas. The study will build on recently completed statewide data collection and analysis of the magnitude and frequencies of peak discharges in Virginia streams. A Scientific Investigations Report for the project will be completed in Fiscal Year 2013.
- A cooperative effort to implement StreamStats in Virginia is underway. StreamStats is expected to be fully implemented early in 2013.

Recent Publications

Austin, S.H., Krstolic, J.L., Wiegand, Ute, Peak-Flow Characteristics of Virginia Streams, U.S Geological Survey Scientific Investigations Report, 2011-5144, 106 p.

Washington

- The WAWSC participates in a multiagency Stormwater Workgroup (SWG), which includes the Washington State Department of Transportation. This workgroup is chartered under the Puget Sound Ecosystem Monitoring program, and is developing a coordinated stormwater-monitoring program in the Puget Sound area. Federal, State, and local agencies, Native American Tribes, business, and environmental groups are represented on the workgroup.
- Initial USGS support for the SWG included an analysis of the streamflow-gaging network for monitoring stormwater in small streams in the Puget Sound basin, Washington. USGS Scientific Investigation Report 2012-5020 describing that analysis was published in 2012.

- Also in FY2012, The WAWSC participated in a newly chartered "Roads and Highways Subgroup" of the SWG. This subgroup will be defining monitoring needs related to roads and highways across the full spectrum of urban to rural roads in Puget Sound, and making specific recommendations as to how Washington State Department of Transportation's permit-required monitoring should address a subset of those needs.
- WAWSC hydrologists have developed and tested new methods to monitor bed movement and scour using:
    - buried accelerometers (http://wa.water.usgs.gov/projects/cedarriverpeakflows/data/Gendaszek_et_al_HMEM_2012.pdf) and,
    - hydrophones (http://wa.water.usgs.gov/projects/cedarriverpeakflows/data/Marineau_et_al_HMEM_2012.pdf).

West Virginia

- A network of crest-stage gages will continue to be operated in cooperation with WVDOT to provide on-going peak-flow data for flood-frequency information and analysis.
- WVDOT provides funding in support of operating and maintaining the streamflow-gaging stations.

Wisconsin

- **Effectiveness of Grass Swales at Reducing Stormwater Runoff from Urban Highways in Wisconsin:** The Wisconsin Department of Transportation (WisDOT) has a Cooperative Agreement with the Wisconsin Department of Natural Resources (WDNR) (November 2002), Trans401 (December 2002), and NR 216 (September 2002), that require the Department to establish a Stormwater Management program to reduce Total Suspended Solid (TSS) loading from highway surfaces. The purpose of this study is to evaluate the performance of grass swales as a stormwater management practice. The primary objective of this study will be focused on measuring the effectiveness of grass swales at reducing stormwater runoff flowing from urban highways. It will evaluate the infiltrative capacity of grass swales and their potential to reduce pollutants such as TSS. This will be done by monitoring a section of grass swale separated into two contributing components: 1) vegetated side slopes and, 2) grassed channel. An additional section will be instrumented to monitor the grass swale as a whole.

  Another goal is to transfer the results from this study to determine if Wisconsin DOT is meeting federal and state standards. The state of Wisconsin allows the use of computer models to determine both volume and TSS reduction. By isolating individual parts of grass swales, parameters in models can be modified to simulate the site conditions.

  Activities for FY2012 included making measurements and collecting samples to determine infiltration rates and pollutant reductions from the swale site. Soils in the swale will be characterized through geo-probing and a double ring infiltration test. Level loggers will be installed between the middle and downstream flume. Plans for FY2013 are to continue measuring and collecting samples to determine infiltration rates and pollutant reductions from the swale site. Soil characterization in the swale will be completed through geo-probing and double ring infiltration test.
- **Flood Frequency Analysis in Wisconsin:** A network of 91 crest-stage gages was operated in cooperation with WisDOT to provide on-going peak-flow data for flood-frequency information and analysis.
- Continued monitoring for bridge scour using acoustic distance-sensing equipment at one site.
- Updated frequency estimates for 367 gages with at least 10 years of record through the 2010 water year, including 47 regulated sites. The analyses used a new skew map developed in FY2011.
- Continued working on updated regression equations using GIS-based basin characteristics and data through the 2010 water year. The updated “Flood Frequency in Wisconsin” report is expected to be finished in early FY2013.
- Worked with StreamStats personnel to determine the steps necessary to implement StreamStats for the State. Decided to use NHDPlus data to develop the GIS layers necessary for StreamStats; final

data are expected to be delivered in early FY2013. Expect implementation of StreamStats late in FY2013.

Wyoming

- No highway related projects at this time.